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The Engineer

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This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non ferrous, is published free with the last issue of THE ENGINEER in each calendar month.

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A Seven-Day Journal

International Works.

THE carrying out of a vast plan of international public works as a means of relieving the industrial crisis was proposed in the early part of last year by the late Monsieur Albert Thomas, Secretary of the International Labour Bureau at Geneva. More than 200 schemes of all kinds were presented by Continental countries, which hoped to profit from this opportunity to build railways, bridges, motor roads, install hydro-electric plants, and execute other works with the aid of international capital. Then it became a question as to how far the works would be justified from the capitalist point of view, and, finally, after the Stresa Conference, it appeared hopeless in present circumstances to expect to get any financial aid at all. The idea of the five years' plan has not been abandoned. The holding of the forthcoming World Economic Conference has suggested to the Committee, which has the matter in hand, that there is still hope for the scheme of international works by presenting it to the Conference as a factor in economic recovery. A meeting was held at Geneva last week, when Monsieur Lambert-Ribot, Secretary of the Comité des Forges, Monsieur Rist, the financial expert, and two eminent French economists were present, and it was decided to make a selection from the works proposed and group them in one plan which the Congress will be asked to discuss. On the Continent there is a singular faith in the efficacy of these public works as a means of improving the economic equipment of States and providing employment to engineers, but unless those works are productive and attractive as investments, they will not obtain capitalist support. There is hardly a European Government at the present moment which is in a position to finance international public works, and the British Government is entirely opposed to them on the ground that "it does not believe in the success of the plan, which it regards as dangerous."

Aeronautical Research Committee.

THE Air Ministry announces that the Marquess of Londonderry, Secretary of State for Air, has appointed Mr. H. T. Tizard to be Chairman of the Aeronautical Research Committee in succession to Sir R. T. Glazebrook, with effect from April 1st, 1933. Sir Richard Glazebrook was appointed Chairman of the Advisory Committee for Aeronautics when it was established by Mr. Asquith as long ago as 1909, and continued in office until that body was reconstituted in 1920 as the Aeronautical Research Committee, when he was again chosen as Chairman. He has throughout taken a leading part in all phases of aeronautical research, and has rendered distinguished services to the science of aviation. Mr. H. T. Tizard, who was born in 1885, has been Rector of the Imperial College of Science and Technology since 1929. He is a member of the Aeronautical Research Committee, and is Chairman of several of the sub-committees and panels. He served as a pilot in the Royal Flying Corps during the war, and later became the first Chief Experimental Officer at the Aeroplane Experimental Establishment at Martlesham Heath. In 1918 he was appointed to be Assistant Controller, Experiments and Research, Royal Air Force, and subsequently was Secretary of the Department of Scientific and Industrial Research. He is a Fellow of Oriel College, Oxford.

Empire Broadcasting.

THE first series of Empire broadcasts for overseas listeners began at 9.30 a.m. on Monday last, and continued until three o'clock on the following morning. Introductory messages were sent out by Mr. J. H. Whitley, Chairman of the B.B.C.; Sir John Reith, director-general; Mr. Noel Ashbridge, chief engineer; and Mr. Cecil Graves, Empire service director of the B.B.C. The remarks were also repeated at 2.30 p.m. for the Indian zone, at 6 p.m. for the African zone, at 8.30 p.m. for the West African zone, and at one o'clock on Tuesday morning for the Canadian zone. During the course of his speech, Sir John Reith said that every day a series of programmes would be sent out to all parts of the Empire somewhere between 5 p.m. and midnight, local time. It had been assumed that the period chosen would be the most convenient for listeners, although it was not necessarily the best from a technical point of view. The Empire had been divided into five zones, and a separate transmission would normally be sent to each. Moreover, it had been arranged to broadcast on various wave lengths to each zone in order to meet the changing seasonal and physical conditions. The consideration of modifications and improvements would be based on the reports received from overseas, and listeners were asked to collaborate with the B.B.C. in that respect. At the outset, it would be necessary to broadcast material of various kinds in order to test reception in the five zones under different conditions. The first programmes would not be very interesting, but later on they would be altered. Without the co-operation of listeners, however, progress would be slow and unsatisfactory. Apart from technical information, it was essential to know the kind of material listeners would like to have, but it was to be remembered that short-wave work had its limitations, and it might be necessary for listeners to confine their suggestions to the type of programme which experience showed to be suitable for good transmission.

Penmaenbach Tunnel.

THOSE who have had the experience of travelling along the Holyhead road between Conway and Penmaenmawr in winter or in stormy weather will welcome the news that the road tunnel under Penmaenbach headland was officially opened last Saturday, December 17th, by Sir Richard Williams, Chairman of the Carnarvonshire County Council. The old stretch of road cut by Telford about a century ago skirted the headland as a narrow shelf 100ft. above the sea, and was not infrequently closed by falls of rock. By reason of its narrowness and its twists and turns, it was always dangerous to traverse, apart from the hazard of falling rock. Since it is to remain open for the use of pedestrians, there is no reason to regret that a route of considerable scenic value is now closed to motors. As constructed, the tunnel now opened is 188 yards long, with a roadway 27ft. wide. It is high enough to accommodate double-deck omnibuses, and is lit at intervals of 28ft. by electric lamps. The project, discussed for several years before it was put in hand, cost £52,818 to carry out. Mr. M. A. Boswell, of Wolverhampton, was the main contractor for the works, while the consulting engineers were Howard Humphreys and Sons, of Westminster. The construction of this tunnel is only one item—although perhaps the most important—in a scheme for improving a considerable length of the Holyhead road in the district. Penyclip headland, further westward, is being circumvented by the construction of two short tunnels and a viaduct.

Luncheon to Sir Reginald Skelton.

ON Friday, December 16th, a farewell luncheon was given to Engineer Vice-Admiral Sir Reginald Skelton by a large number of Admiralty contractors, who desired to show their recognition of the ability with which he had acted as Engineer-in-Chief at the Admiralty—a position from which he retired on December 1st. The luncheon party was held at the Victoria Hotel, Northumberland-avenue, and representatives from firms all over the country were present. The chair was occupied by Mr. Richard Allen, who had organised the function. On his right hand sat Engineer Vice-Admiral Sir Reginald Skelton, and on his left Engineer Vice-Admiral H. A. Brown, the present Engineer-in-Chief. In a graceful speech Mr. Allen referred to the cordial relationship which had always existed between Sir Reginald and naval contractors, and wished Sir Reginald and Lady Skelton *bon voyage* on their coming trip to New Zealand, a happy return, long life, and happiness. Acknowledging the toast Sir Reginald Skelton said that one of his most important duties concerned the engineering *personnel* of the Navy, which amounted to about 25 per cent. of the whole, and he not only had to see that the officers were suitably trained, but also to see that their conditions of service were such as would keep them happy and efficient. There was, he said, about 7,000,000 H.P. in the Navy. The relations with the engineering industry and the mercantile marine had been always most happy, and he had never looked in vain for assistance. It occasionally happened that he was invited to try out advanced ideas in the Navy, and it was not always possible to meet the enthusiasts' wishes. On the other hand, the Navy occasionally led the mercantile marine and introduced features in advance of commercial practice which were later taken up generally. It was gratifying to feel, therefore, that efforts primarily directed to develop warlike weapons, probably paid a dividend, so to speak, in the form of aiding the development of merchant ships and thereby speeded civilisation by adding to the facilities for ocean transport. As to the design work, he had spent most of his service time in running ships afloat rather than in design, and he left his office with the greatest admiration for the vision, courage, and enterprise of his predecessors in developing naval engineering designs.

"The Flying Hamburger."

ON Monday last, December 19th, successful running trials were made between Berlin and Hamburg, with the experimental two-coach, streamlined train, equipped with oil-electric propulsion, which has been built for the German State Railways by the "Wumag" wagon works of Görlitz, and engined by the Maybach Motoren-Gesellschaft in conjunction with Siemens-Schuckert, of Berlin. The new train, which weighs 77 tons, maintained an average speed of 76·5 miles per hour on the 286 kiloms. line between Berlin and Hamburg, and a maximum speed of 91 miles per hour was attained. The run was made in 2 h. 19 min., or about forty minutes less than the time usually taken by the fast Hamburg-Berlin expresses. After further tests the new train will be overhauled and prepared for regular summer service. The two coaches each have a length of 68ft., with one blunt and one rounded end. The two blunt ends are coupled together, and in the streamlined noses so formed at either end of the train are housed the twelve-cylinder V-type Maybach 410 B.H.P. airless injection engine, with the generators and Siemens-Gebus electrical controls to the driving motors. The two coaches provide seating accommodation for 102 passengers, and a refreshment buffet is included in one coach, while in the other the same space is given up to luggage and lavatory accommodation. Substantial running economies are expected from this new type of train.

New Steel Plant for Lancashire.

THE announcement is made that the Lancashire Steel Corporation, Ltd., has acquired the undertaking of the Whitecross Company, Ltd., of Warrington, and that a development scheme, estimated to cost about £1,750,000, including the construction of a modern continuous wire rod mill, will be immediately proceeded with. The Lancashire Steel Corporation, Ltd., was formed in 1930 to take over the control of the interests of the Partington Iron and Steel Company, Ltd., the Wigan Coal and Iron Company, Ltd., Pearson and Knowles, Ltd., and Rylands Brothers, Ltd., and the new acquisition makes a further contribution to the scheme of rationalisation for which the corporation was founded under the auspices of the Securities Management Trust, formed by the Bank of England to assist industrial reorganisation. When the new wire mill is completed, it will be one of the largest and most modern plants of its kind in this country, and the rods will be manufactured from steel produced on the one site. The new plant will supply not only the wire work of the Whitecross Company and Rylands Brothers, but also other consumers in the Lancashire and other areas. Wire netting, barbed wire, and wire nails will also be manufactured, which will replace goods hitherto made from imported billets or wire rods. The new scheme is being principally financed by the Bankers' Industrial Development Company, the second of the companies formed under the auspices of the Bank of England in order to assist industrial reorganisation.

Official Assistance in Industry.

DEALING with the general trade position in a recent speech, Sir T. Harris Spencer, the chairman of J. Brockhouse and Co., Ltd., of West Bromwich, entered a plea for official asisstance in righting existing trade wrongs and for the building up of industry generally. Referring to the Ottawa Conference, which he considered had been successful in establishing the principle of more extensive Empire trading, he pointed out that goods that were made with foreign labour were coming into this country through what was called the Empire corridor. By this means they got the advantage of admission to this country without paying their proper quota of the *ad valorem* duty and the additional duties set forth under the Import Duties Act. The Board of Trade, he suggested, should assist British manufacturers by putting a stop to such a practice. Sir Harris Spencer urged further that the same body should really make very necessary inquiries into the state of trade in this country, and also make periodical examinations into the falling off of trade in order to find out the reasons for it, and should do more than merely compile statistics. Industrialists wanted the Board of Trade to co-operate with the manufacturers of this country in order that industry could concentrate on the causes of depressed trade, and see if it could counteract them. The Board of Trade must become a live body, fully representative of the trade and commerce of the country.

Shipping Subsidies.

IN the course of his address at the annual meeting of the Orient Steam Navigation Company, Ltd., which was held in London on Tuesday, December 20th, Sir Alan Anderson referred to the fact that one nation after another had become possessed of the desire to fly its flag on merchant ships, and, by giving enormous subsidies, had dumped shipping services on the world, with the apparent object of ruining those shipowners who tried to make ends meet. After recalling the subsidised shipbuilding programme of both France and Italy, Sir Alan dealt more fully with the American position. He pointed out that, according to the official reports of the United States Shipping Board, it appeared that the total expenditure by the American taxpayer on American merchant shipping for the twelve years from 1920, excluding interest, had been about £600,000,000 at par, or about £50,000,000 more than the total payments made on account of war debts by all her debtors down to last year. It seemed, Sir Alan continued, that the more spending power was poured into the United States the more resolutely did that country apply that wealth to prevent the debtor from repaying or recovering his prosperity, which, he pointed out, was as necessary for the farmer, the industrialist, and the investor of the United States as for anyone. The Chamber of Shipping of the United Kingdom recently adopted the findings of the meeting of international shipowners at the International Chamber of Commerce in Paris, advocating strongly the removal of all uneconomic subsidies and other trade barriers.

Construction of a Long Inlet Pipe Line, Lausanne Water Supply.

THE town of Lausanne, capital of the Canton of Vaud, Switzerland, has a population of about 80,000. The potable water supply is drawn from springs in the mountains to the north of the town, and there is a further supply of filtered water for street watering and industrial purposes drawn from the Lac de Bret, a small lake, artificially increased in capacity by a barrage, on the western slopes of Mont Pélerin, near Vevey.

The latter supply is being increased by the construction of a new pumping station on the shores of the Lake of Geneva, at Lutry, 3 miles east of Lausanne. This supply is to be drawn from the lake at a point 1240ft. from the shore, and 124ft. below the surface of the lake, which is 169ft. deep at the mouth of the inlet pipe. Careful analyses taken over a long period show that the water at this point is organically and bacteriologically pure, and at all seasons free from *B. coli*. In cold weather, however, the *plankton* in the lake descend to considerable depths, and would be found in the water at the mouth of the pipe. For this reason rapid filters are being constructed at the pumping station and apparatus for chlorinating the water, if necessary, will also be provided.

At the point decided upon for the intake, the floor of the lake falls gradually from the shore at a slope of about 1 in 30 for 670ft., from which point there is a sharp drop at a slope of 1 in 5 to the greatest depth of the lake, 1095ft.

Owing to the distance of the inlet from the shore, and its position relative to the surface and bottom of the lake, careful consideration had to be given to the design and placing in position of the inlet pipe, and the method eventually adopted presents some features of interest.

FIG. 2—DOUBLE EXPANSION JOINT

This pipe is of mild steel, 47 cm. internal diameter and 8 mm. in thickness, electrically welded throughout with the exception of two flanged joints in its total length of 1315ft. The section laid on the bottom of the lake is welded in one length of 1195ft., and, to secure the necessary flexibility, so that the pipe when lowered should adapt itself to the contour of the lake floor, a number of corrugations are formed in the pipe at suitable intervals.

Fig. 1 shows parts of the pipe from the inlet to the sump in the pumping station and indicates the position of the flexible joints. These are either single or double—see Fig. 2 and 3, Fig. 1—according to the amount of flexibility required in the pipe at the point where they are inserted. The flexible corrugations are formed of circular rings of extra ductile steel plate, pressed out to the section required and welded in pairs into the pipe to form either single or double corrugations. The pipe may be bent at a single corrugation to an angle of 7–8 deg., and at a double one to 15 deg. from its axis. The double corrugations were submitted to a test of 20 deg. deflexion.

The pipe was constructed in short lengths by Messrs. Giovanola Frères S.A., at their works at Monthey in the Rhone Valley. These were transported in the first instance to Bouveret, where the pipes forming the longest section of 1195ft., were assembled on trestles on the banks of the Stockalper Canal, and welded into one single length. Steel brackets were welded on to the pipe at suitable intervals, to secure four baulks of fir, 15 cm. by 22 cm., running the whole length of the pipe. These are shown in section in 4, Fig. 1, which also shows the method of securing protecting rings of thin sheet steel placed round each of the corrugations to prevent damage to them during transport and lowering into position. The pipe was then closed with blank flanges at either end, and having been launched into the canal it was towed across the lake to its position at Lutry, a distance of 12 miles in a direct line.

Fig. 5, page 642, shows the pipe being lowered down the banks of the canal. As the canal had recently been widened, the banks were free from trees or other growths, and the operation of launching the pipe presented no difficulties. Incidentally, it may be mentioned with satisfaction that the widening of the canal was carried out by the aid of British machines, two motor-driven excavators mounted on caterpillar carriages, constructed at Lincoln by Ruston-Bucyrus, Ltd., being used for the work.

The reason for fitting this length of pipe with the timber baulks, which are of spruce fir, was to secure a low specific gravity after slowly filling the pipe with water, so that it might sink gradually and be easily under control, while being lowered into its position. With the timber dry, the specific gravity of the pipe floated for towing was 0·335, and when filled with water during sinking 1·12.

As the operation of sinking the pipe in position was carried out from the surface without any assistance from divers or diving tackle, the design of the vertical inlet pipe with its mouth 44ft. above the bottom of the lake, and the question of lowering it, after connecting it to the outer end of the horizontal pipe while afloat, presented some interesting problems.

The inlet is not fitted with a retaining valve and consists of a steel cap over the open end of the pipe with the simple protection of a cage of steel rods—see Fig. 8. Immediately below the inlet a steel cylinder 1·38 m. diameter and 1·2 m. long is welded round the pipe, forming a float to preserve the vertical position of the pipe when sinking and to relieve strain on the bolted flange at its junction with the horizontal pipe.

The vertical inlet pipe is mounted on a triangular frame of rolled steel joists resting at each angle on a rectangular steel caisson 1·2 m. deep. Two of these caissons are 1·5 m. by 1·5 m., the third at the junction of the vertical and horizontal pipes being 1·90 m. by 1·50 m. The vertical pipe was erected on the shore of the lake at Lutry and, as shown in Fig. 3, is in the form of a tripod, one leg of which is formed by the pipe itself, while the other two legs are of rolled steel, the whole being reinforced with strong scantlings of spruce fir. The caissons are welded at all angles to form air-tight boxes. Each was fitted with a 1¼in. plug cock controlled by rods from the surface, and with a vertical air outlet pipe ¾in. diameter and about 3 m. long, so that the rate of admission of water to the caissons during sinking could be regulated as required. As the triangular frame carrying the inlet rests on a slope of 1 in 5, provision was made for anchoring it in place. Each of the three caissons was fitted with six angle iron grabs projecting 30 cm. below the underside—see Fig. 4—and also with a heavy steel anchor plate

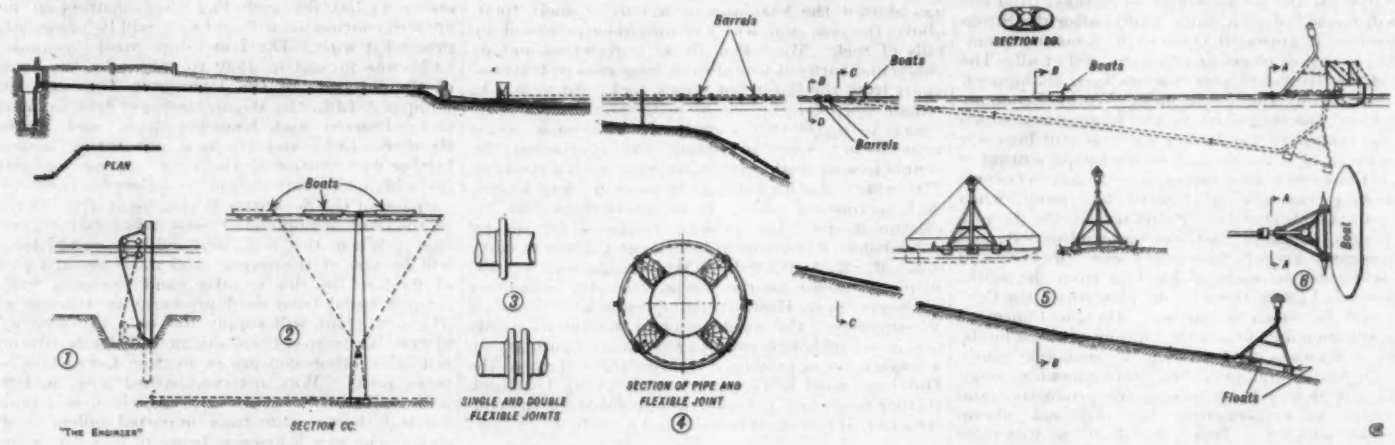


FIG. 1—INLET PIPE LINE IN THE LAKE OF GENEVA

FIG. 3—THE INTAKE PIPE AND TRESTLE

fitted with trip gear which automatically released the anchor at the moment when the inlet end of the pipe reached its final position at the bottom of the lake. In cross section A–A (5, Fig. 1) these anchors are shown raised when the caissons were floating on the surface. The method adopted for releasing the anchors is shown by the diagram Fig. 4. The anchor plates are connected to one side of the caisson near the bottom by a steel tie rod held in position at its lower end by a loose bolt and bracket. The anchor was kept raised until required by a flat plate riveted at one end to the anchor tie rod and held temporarily in position by a nut on a stud fitted to the top plate of the caisson. A vertical rod is carried by brackets on the side of the caisson with its upper end immediately below the tie plate holding the anchor in position. The lower end of this vertical rod is fitted with a tripper plate and the rod is of such length that this plate would touch the bottom before any other part of the structure. Immediately before the operation of sinking the pipe was commenced, the nuts holding the anchors in the raised position were removed so that, during the lowering of the pipe, the anchors were kept raised by the tension on the tie rods due to their own weight. Immediately the tripper plates touched the bottom of the lake the raising of the vertical trigger rods released the tie plates and the anchors dropped into

position. Any movement of the caissons in a lateral direction was thus rendered impossible from the moment they were lowered into position.

Before describing the operation of lowering the pipe, reference may be made to the section Fig. 1, from which it will be noted that, instead of keeping the pipe below the level of the lake at the shore end, it has been raised above that level between the lake and

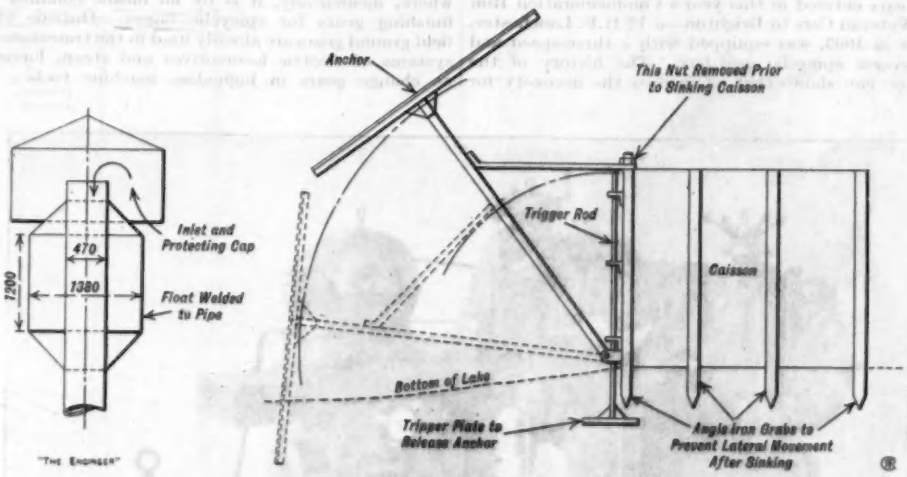


FIG. 4—CAP AND ANCHORAGE OF INTAKE PIPE

the pumping station, thus forming a syphon. There were local reasons for this, and to maintain the flow of water a steel air vessel has been provided near the end of the horizontal part of the pipe. An apparatus is provided which automatically starts a motor-driven air pump whenever there is an accumulation of air in the syphon. The capacity of that part of the pipe which is above the level of the lake is only about 15 cubic metres. The variation in the level of the Lake of Geneva does not exceed 1 m., the lowest level being reached in early spring.

The operation of placing the pipe in position was carried out as follows:—For a distance of 200 m. from the shore a trench had been dredged averaging 1 m. in depth, on the side of which posts of pine, 25/30 cm. diameter, were driven, to which the floating pipe was lashed with ropes with one end secured to the post at the bottom of the trench—see 1, Fig. 1. These lashings were released as necessary during the lowering of the pipe, and the posts served as guides for the line of the pipe during the operation. After the pipe had been lowered in place the posts were sawn off under water at the level of the lake bottom, and the trench filled with pebbles to prevent damage to the pipe from yacht anchors and other causes in the shallow water. The lowering of the outer end of the pipe in deep water was controlled at three points, marked A–A, B–B, and C–C in Fig. 1. For temporary extra floating support to the pipe at the commencement of the operation, empty casks in pairs were lashed to it with old rope at suitable intervals, these lashings being cut under directions from the engineer in charge of the operations at moments which were so arranged that the outer end was first lowered until the pipe was parallel to the slope of the lake bottom, when it was lowered throughout its length until all sections of the pipe reached the bottom at approximately the same moment. A small cargo steamer—6, Fig. 1—was anchored fore and aft at the outer end of the pipe, and the inlet cap was secured by means of a wire rope to a small crane fitted on the deck. Two centrifugal pumps on the ship were each arranged to deliver water through a hose into the pipe to load this end sufficiently for sinking, while the caissons were simultaneously filled with water by the arrangement already referred to. This arrangement is shown by the photograph reproduced in Fig. 8.

At the point B–B anchors had been fixed at either end of a line, 200 m. long, drawn at right angles to the pipe. The cables from these anchors were run over winches in two rowing boats, placed on the line. These boats were then connected together by a steel cable running *under* the pipe, which was thus at this point slung between the two boats. By slacking out their anchor cables the boats approached each other, and the pipe slung between them was lowered at this point. At the point C–C—see 2, Fig. 1—this operation was reversed, so that the pipe, empty at this point, was forced down in the water as required to follow the movement of the outer section of the pipe, which was being lowered by its own weight. To arrange this, the lower ends of two steel cables were attached to concrete blocks, each weighing 700 kilos., sunk in the lake on either side of the line of the pipe. These cables were passed *over* the pipe in opposite directions and the ends attached to rowing boats. By hauling the boats apart, as required, on a line at right angles to the pipe, this section was forced to sink until it was filled with water, owing to the submerging of the inlet.

The plans were so carefully arranged and the men in charge so well drilled to their work, that the pipe was placed in position well within the time anticipated. The work was carried out in favourable weather on June 8th, 1932. The pipe left Bouveret in tow at 5 a.m. on that day and arrived at Lutry at 8 a.m. The staging with the vertical inlet pipe was then launched, and towed into position and bolted to the horizontal section then floating on the surface. The pipe had been lowered into position and the work completed by 2.30 p.m. on the same day, under the supervision of Monsieur Meylan, water supply engineer, Lausanne, and MM. Giovanola and A. Chevalley, representing the manufacturers of the pipe.

Statistics and Engineering.

By DUDLEY W. WALTON, F.S.S.

No. III.*

Probability and Correlation.

THE statistical process described in the first article of this series (THE ENGINEER, December 9th, 1932) as "systematic guessing" is assisted by means of the general theory of probability. This theory enables the degree of credence inherent in a statement or conclusion to be reduced to calculation. The basis of all probability is that the probable is more likely to happen than not to happen. In the simplest case of alternatives, one of the alternatives is certain to happen. An assembled unit will work or it will not work. When tossing a penny, it must come down either as a head or a tail. Interpretation in such matters is influenced partly by knowledge and partly by ignorance. Certainty is the result of complete knowledge, as, for instance, that in dealing a pack of cards, the ace of diamonds will certainly fall into one of the hands. This degree of probability is represented by unity. Uncertainty is the result of ignorance. The knowledge that an event cannot happen is a form of certainty and is represented by the symbol zero.

There is a distinction to be made in respect of probability between a cogent and an insufficient reason. There is a cogent reason for expecting to find a measurable and therefore an argumentative probability in the matter of a capacity of a pipe to withstand a determined pressure. Here we know the pressure and we know something (but not everything) about the behaviour of the pipe. But we are not justified in postulating any measurable probability when a rod of unknown section is subjected to an indeterminate stress. Unless we have some kind of experience or possess some degree of knowledge, we must accept a probability, if calculated, with insufficient reason. A Lloyd's underwriter will write a policy for almost any unknown risk, but only because he has had experience of other unknown risks. Here he has a cogent reason for acting upon insufficient information. The engineer has a cognate problem presented to him when he puts up a line of wooden telegraph posts across a bleak moorland. The poles may or may not stand up against the worst of winter storms.

A probability example of certainty is a life assurance policy which will ultimately mature, but in boiler insurance the boiler is not certain to explode. Again, if a rise of temperature is recorded from 100 deg. to 200 deg. between 9 a.m. and 10 a.m., it is certain that at some time in the interval it registered 150 deg. What is the probability that it was 150 deg. at 9.30 a.m.? A curve on a chart would indicate the probable answer, but it is only a probable answer, which by known principles of sampling with single instances is equally probable to be correct or incorrect.

In statistical methodology probability is used in curve fitting, and is of service in determining the limits of the accuracy of the induction. A curve, and especially a smoothed curve, is almost certain to be a compromise with the recorded facts, and one curve may fit the data better than another. Tests of goodness of fit can be used to determine the degree of probability that the curve does represent the relationship assumed to exist. This can be done in one way by noting the differences between the recorded measurements and the values of the points on the curve. To justify the probable accuracy of a curve, the range of these differences should fall within some margin of error, as calculated by applying the theory of probability to the observed differences. A method of accomplishing this was shown in the second article of this series, and a more refined method will be indicated later under the heading of Statistical Control of Production.

* No. II. appeared December 16th.

Old and New Experiences.

Probability can be applied to the relationship of events which have already happened or to those likely to happen. Calculations that the new experience will resemble the old are said to be empirical or *a posteriori*. Probabilities where one or more events must happen, as in the case of drawing cards from a pack, are said to be *a priori*. Mark Twain confused the *a posteriori* and *a priori* methods when he said, "Give me statistics and I'll prove anything. Ninety-nine per cent. of the population die in their beds; therefore bed is the unsafest place in the world."

Some determinations of the probability of an event happening involve more mathematics than can conveniently be given here. Calculations regarding the behaviour of the molecules of a gas are highly mathematical. The probable population of a given country at the end of the twentieth century (a matter of concern in many engineering undertakings) has been calculated by a refined and elaborate method, using the logistic curve. Some of Laplace's calculations of the probable behaviour of the moon covered dozens of pages of algebra. If James Watt had tested his steam pressure relationships statistically, or if Joule had examined his mechanical equivalents of heat by methods now available, their results would have been accepted as probably correct only within calculated margins of error and the extent of the error inherent in all formulæ derived *a posteriori* from sample observations would have been detected.

The simpler forms of the calculation of probability need only simple arithmetic. The chances of cutting an ace in a pack of cards can be calculated in one's head. There are four aces in the pack of 52 cards so there are four chances of success and 48 of failure. The symbolic representation is $\frac{1}{13}$ derived from the formula $P=\frac{h}{h+f}$, where P is the accepted symbol of the probability of an event happening, h is the number of ways in which the event can happen, and f the number of ways it can fail. The symbol Q is used for the probability of an event not happening, and

$$Q=\frac{f}{h+f}$$

It is clear that P and Q together equal unity. P is, of course, a ratio. Hence the probability of drawing any ace from the whole pack or the ace from an isolated suit is the same.

A Problem in Probability.

An engineering problem in probability would arise in a case of having a record of fluctuating measurements for fifty-two consecutive weeks. What is the probability that the fifty-third week will resemble the first or the fifty-fourth week the second? This can be stated more simply in the terms of a card problem. Shuffle two packs of cards separately and lay them side by side. What is the chance that the two top cards will match each other? At first glance the chances against the event happening seem to be enormous. But the problem is not affected by the designation of the top card of the first pack. Suppose it is the king of spades. The problem is to calculate the probability that the king of spades is at the top of the second pack. Using the formula, it is found to be $\frac{1}{52}$. Suppose further that failure to match the card occurs. What is the probability that the second pair will match? It appears at first sight to be $\frac{1}{51}$, but this overlooks the fact that having eliminated the king from the first pack, his mate in the second pack is useless. He remains in the second pack as an additional chance against success. The calculation for the second pair is therefore $P=\frac{1}{50+1+1}=\frac{1}{52}$. There is exactly the same probability for the third and all subsequent pairs. The chance of pairing occurring if we make the experiment with the whole pack is also 1 to 52, because there are 52 equal chances of the event happening. This is the argument from cogent reasoning. However, there is an insufficient reason also. If the first 26 cards in the first pack were mated collectively by the second 26 cards in the second pack, the pairing would be impossible. The chance against this happening is extremely high; equal, in fact, to half the probability of each partner holding a complete suit in dealing four hands.

Contingency and Correlation.

The theory of probability is applicable to cases of related or assumed-to-be related phenomena. When it is known in advance that a causal relation-

ship exists between different events the relationship is said to be contingent. When the causal relationship is merely suspected, the term correlation is used. A correlation of cause and effect may be apparent and established by sound mathematical proofs, and yet be entirely fallacious as an argument. There are often "nonsense-correlations" found in the field of economics. There is the "classical" instance of the correlation between the imports of bananas and the tonnage of battleships. In a certain scholarship examination it was observed that the final order of merit correlated highly with the order of marks in a certain subject of the examination. Tutors therefore inferred a bias in the minds of the examiners, and crammed future candidates accordingly.

An argument derived from the application of the theory of correlation is necessarily inductive, and has the inconclusiveness associated with inductive logic. There is a tendency in this branch of statistics to meet the expectation; to start with the induction or the inferred cause and support it by some method of correlation rather than to calculate the value of the correlation to see if it leads to a valid induction of assumed relationship. The degree of probability of an assumed relationship is measured by the coefficient of correlation, commonly designated r. Elaborate formulæ for these calculations are available, as well as certain simplified procedures and tables. In most correlation problems in engineering it is not necessary to measure the correlation with the utmost exactitude, but only to ascertain whether it is more or less. For this purpose an empirical statistical device, known as the Spearman "foot rule," can be used from the formula

$$r = 1 - \frac{3 \Sigma \delta}{N^2 - 1}$$

that is, unity diminished by three times the sum Σ of the differences δ divided by the square of the number of items less 1. The differences denoted by the Greek letter δ are the positive ordinal differences in the items when one of the series is arrayed by magnitude, as illustrated by applying the Spearman formula in the following simple case:—

Suppose in the testing of ten motor vehicles that the speed in miles per hour and the distances in feet determined when stopping each car are respectively, 4 m.p.h. (2 feet), 7 (4), 17 (50), 14 (36), 12 (20), 11 (28), 20 (48), 15 (54), 17 (40), and 13 (34). Array the mileage in order of magnitude (a) and determine the order of the second quantity (b) thus:—

(a)	Speed, m.p.h.	Distance, feet.	(b).	Positive difference, (b) minus (a).
1	4	2	1	—
2	7	4	2	—
3	11	28	4	1
4	12	20	3	—
5	13	34	5	—
6	14	36	6	—
7	15	54	10	3
8	17	40	7	—
9	17	50	9	—
10	20	48	8	—
			Total ..	.. 4

$$\text{Then } r = 1 - \frac{3 \times 4}{100 - 1} = 0 \cdot 878.$$

In the above case there is a high degree of correlation. The correlation, indeed, as might be expected from general considerations, merges into a concept of contingency, or actual causal relationship. The value of $r = 0 \cdot 878$, compared with unity, measures the probability of the existence of a causal relationship between the speeds and the distance to stop. Usually any value of r above $0 \cdot 75$ shows a high degree of correlation. There are occasional cases of negative correlation, as, for instance, if the order of the items in column (b) were reversed with respect to the order in column (a). When a negative correlation is apparent from inspection, either the figures in column (b) can be reversed (so that 1 = 10 and 10 = 1), or the negative correlation can be illustrated by drawing the curve the other way round on a graph. Many diagrams published from time to time in THE ENGINEER would be made clearer to the eye by this procedure.

Correlation can only be determined between phenomena of the same order, either objective or subjective; that is to say, a coefficient of correlation may be calculated for measureable or estimated quantities in matters of quantitative evidential-judgement or for matters of value-judgement which can be qualitively compared. The attempt to correlate dissimilar phenomena is worthless for any purpose of establishing an argument. There is no relationship between an objective quantity of heat units and the number of people who subjectively prefer toast for breakfast!

(To be continued.)

THE steamship service between London and Boulogne, which has been run for many years by the Bennett Steamship Company, Ltd., has been taken over by the General Steam North France Lines, Ltd., which will run the service as hitherto. The General Steam Navigation Company, Ltd., ran a steamer service between London and Boulogne from 1826 to 1885.

Precision Grinding Machines.

No. XIV.*

GEAR GRINDING.

THE use of an epicyclic gear-box in a motor car is not so new an application as it may seem to those who have only heard of it in recent years. One of the cars entered in this year's Commemoration Run for Veteran Cars to Brighton—a 12 H.P. Lanchester, built in 1903, was equipped with a three-speed and a reverse epicyclic gear-box. The history of the motor car shows that as soon as the necessity for several gear ratios in the transmission of a car was realised, the thoughts of automobile engineers were directed towards the epicyclic gear, of which all the teeth are in constant mesh. At that early date, however, epicyclic gears, except in the very simple form later used on the old type of Ford, though excellent in theory, were found in practice to be unsatisfactory. In a single epicyclic gear with three planet wheels, at least two teeth of each planet are in engagement, one with the sun wheel and the other with the outer ring. So that, in this single epicyclic, no less than six pairs of teeth are concerned with transmitting the drive. In the early days of motor car manufacture, difficulty was found not only in discovering materials strong enough to stand up to the high stresses imposed, but also in cutting the teeth with the accuracy necessary to ensure that the load was properly shared. The disfavour into which the epicyclic gear later fell was partly caused by the fact that "clash" gears could be made more cheaply, but, to some extent, owing to troubles experienced because one pair of teeth tended to take too great a share of the load at the expense of the rest. With the advance of engineering skill, the epicyclic gear-box is again coming into favour. Nowadays, the accuracy of gear-making is such that in an epicyclic box in which, on the indirect gears, as many as twenty-four pairs of teeth are concerned in transmitting the drive, reliance can be placed on an exact equality between the loads carried by each pair. The majority of, if not all, such gears are finished by grinding.

The gear-grinding machine probably finds its greatest field of usefulness in automobile engineering, where, incidentally, it is by no means confined to finishing gears for epicyclic boxes. Outside this field ground gears are already used in the transmission systems of electric locomotives and steam lorries; as change gears in high-class machine tools; as reduction gears in aero engines, and as timing gears in oil engines, to mention but a few applications. The use of ground gears wherever heavy loads have to be carried, particularly at high speeds, is always worth consideration for, under such arduous conditions, accuracy in the form of the teeth is of great importance if the mechanism is to run silently and efficiently and to have a long working life.

The respective fields of usefulness of cut and ground gears come hardly within an article devoted exclusively to grinding. It is worth pointing out, however, that certain types of gears such as those with long addendum teeth, are more easily ground than cut, while tooth forms modified with the object of relieving stresses when heavy loads are carried are produced with ease by grinding. The gear-grinding machine, also, has the advantage that it can operate upon the already hardened gear, so that the accuracy of the final product is not affected by subsequent heat treatment.

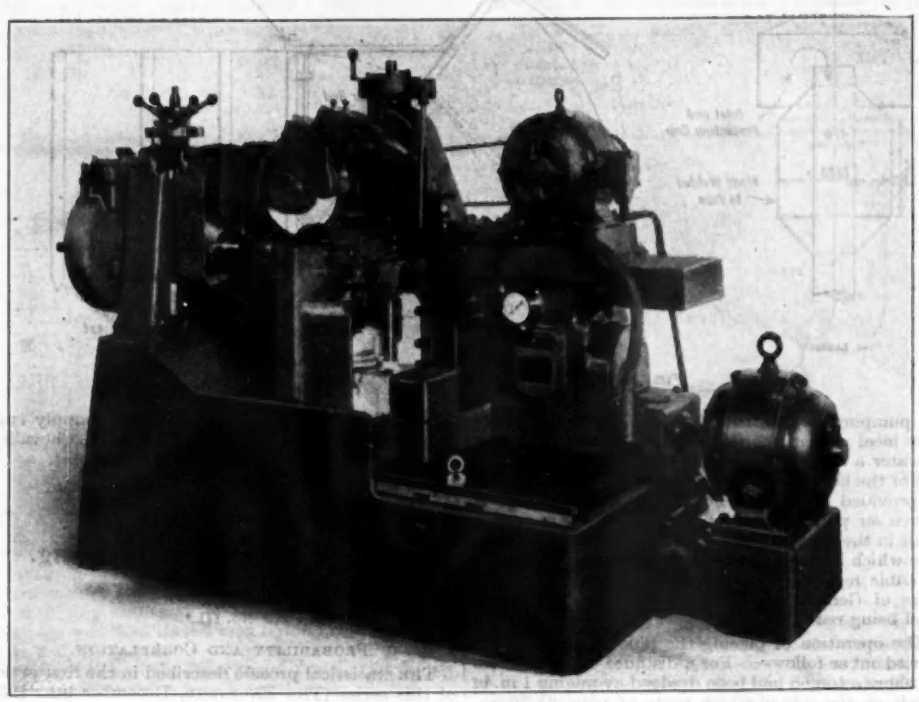


FIG. 101—GEAR GRINDING MACHINE—GEAR GRINDING COMPANY

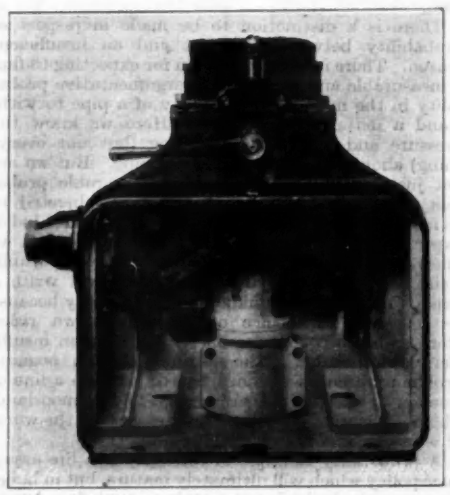


FIG. 102—FORM PLATES IN POSITION

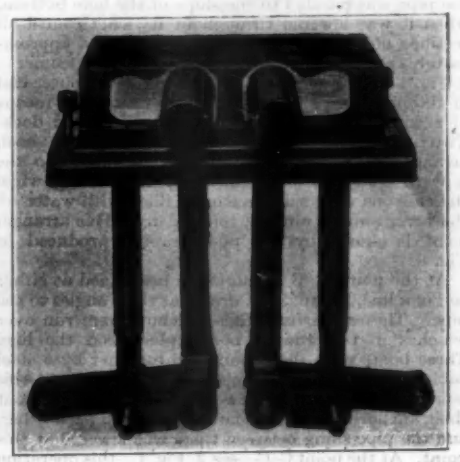


FIG. 103—PANTOGRAPH UNIT

More than one method of gear grinding is in use at the present day. Probably the most important methods are those two in which either the form of the tooth is generated by flat-sided wheels, or is shaped directly by a formed wheel. In this series of articles the Maag-Sulzer machines have been taken as representative of the first type, and the machines made by the Gear Grinding Company, Ltd., of

* No. XIII. appeared December 16th.

Handsworth, near Birmingham, as representative of the second.

FORMED WHEEL GEAR GRINDING.

While the "generator" gear grinder is in geometrical theory a better machine than the "former" grinder, there is, in fact, little to choose between

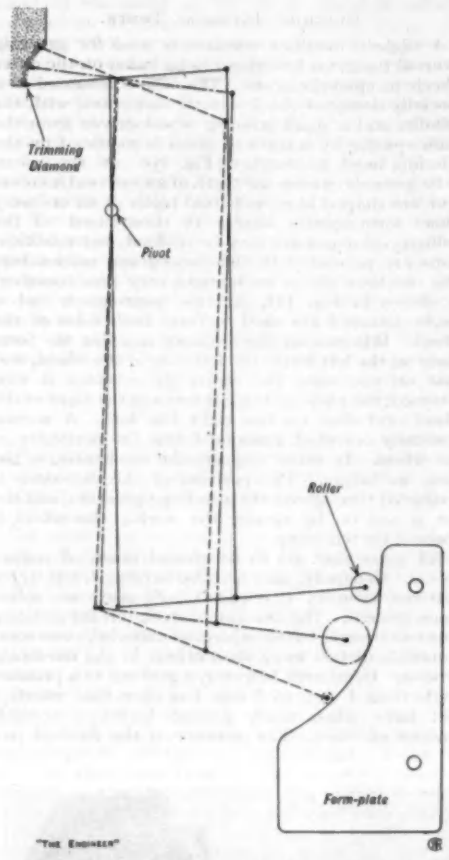


FIG. 104—CORRECTION FOR DIAMOND WEAR

the products of each class. At the same time, the makers of formed wheel gear-grinding machines claim several advantages over the other type. The more important of these claims are that nearly all the parts of the "former" type grinder may be similar, or nearly similar, to corresponding parts on any first-class machine tool; that, since the wheel

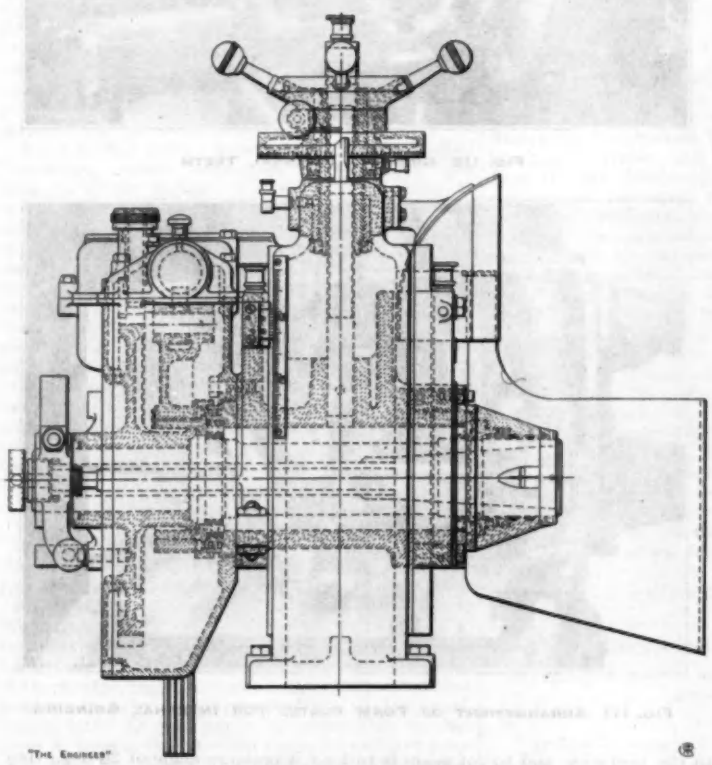
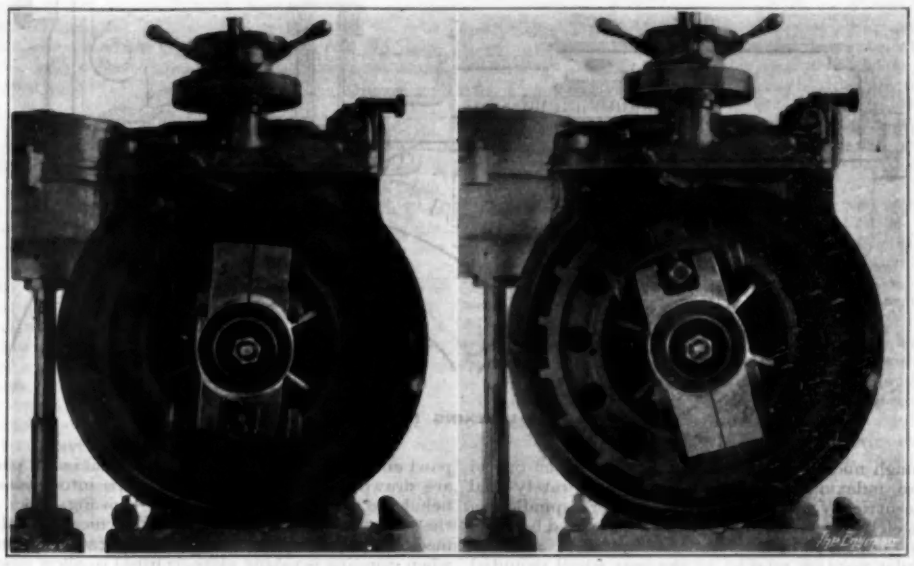


FIG. 105—WORKHEAD OF GEAR GRINDER

is strong and operates on both sides, much rougher cuts are possible than on "generator" grinders, and that, consequently, high productivity is possible. It is also pointed out that, whereas in a "generator" grinder the various parts are interconnected, in the machine made by the Gear Grinding Company the work spindle, the grinding spindle, the indexing mechanism, and the pantograph mechanism controlling the diamonds are separate units which may be adjusted or removed and replaced by others without disturbing any other part of the machine.

ARRANGEMENT OF FORMED WHEEL GRINDER.

The general features of a machine made by the Gear Grinding Company may be seen in the half-tone engraving, Fig. 101. The grinding spindle is carried on the vertical guides of a short column mounted on the main table of the machine. This table is reciprocated by a hydraulic mechanism and is usually set to travel at one particular speed. If lower speeds are required, however, they may be obtained by the use of a control valve. Besides the column the table also carries a 2 H.P. motor running at 1440 r.p.m., which drives the grinding spindle through an endless belt. A second motor of 3 H.P. mounted on an extension at the right-hand end of the bed drives the pump for the hydraulic mechanism. Both motors are controlled by push buttons and the table is set in motion by the use of a control lever. Reversal of the table motion is brought about by adjustable dogs at the back of the bed, and a trip lever placed close to the operator's right hand allows the table to overrun the dogs when trimming becomes necessary. The trimming diamonds may be arranged to come automatically into operation when the table is run back, or alternatively they can be started by hand. The movements of two of the three diamonds necessary for trimming are controlled by form plates mounted in a casing vertically below the trimming position of the wheel. The casing has its cover removed in the illustration. The position of the third diamond depends partly on what shape it is desired to give to the bottom of the spaces between the teeth. In the illustration it is mounted near the top of the wheel guard and forms the wheel so that the flanks of two adjacent teeth are connected by a circle of suitable radius. This form, which was developed by the Gear Grinding Company, actually strengthens the teeth and appreciably increases the life of the gear wheel under service. On other machines this third diamond is mounted between the other two and gives the edge of the wheel a flat surface connected with the flanks by curves of small radius. Wherever it is mounted this diamond is operated by hand, while the other two are operated by power. In order to allow for wheel wear there is no vertical motion of the diamonds but the grinding spindle is fed down the slides of the column. Thus the periphery and formed sides of the wheel are always in the same position relative to other parts of the machine. Cut is put on by raising the work spindle by means of the hand wheel to be seen mounted above the work head in the engraving. Since the position of the diamonds is fixed and the grinding wheel is never moved vertically except for trimming, a definite level can be found to which all gear wheels of one particular shape and diameter must be raised if the gear teeth are to be correctly formed. Once this position is found any number of gears can be ground dead to size merely by raising the work spindle to the correct position, and trimming the wheel before each finishing cut. A simple but highly accurate indexing mechanism is carried at the back of the work head, and the gears to be ground are held



FIGS. 106 AND 107—ACTION OF INDEXING MECHANISM

on suitable arbors which are pulled back into a taper hole at the front of the work spindle.

CONTROL OF TRIMMING DIAMONDS.

It has already been mentioned that the movements of the diamonds are controlled by form plates. A "close-up" view of these form plates mounted in position is provided by the illustration Fig. 102, while the pantograph unit is shown in Fig. 103. The form plates are made of mild steel, a pair for each type of gear, and they are six times greater in size than the actual gear teeth. They are milled on a machine controlled by a master plate three times as large as they, which is cut to an accuracy of 0·001in. of the correct shape. Since the pantograph gives a reduction of 6 : 1, the accuracy of form of the trimmed wheel is likely to be within 0·0001 of the correct shape. The form plates are each located in position by two pins and provision is made for delicate side and vertical adjustment by thumb screws, for the position of the plates governs to some extent the shape generated on the wheel. The pegs at the ends of the longer levers of the pantograph are held against the form plates by a spring. When setting up the diamonds are put in position by a gauge which slips over the ends of the diamond spindles. The diamonds are pushed up against a flat surface, which sets them at the correct distance from the centre of rotation. Correction for diamond wear may be applied by changing the pegs that bear on the form plates, the principle being illustrated in Fig. 104. Supposing, for instance, that pegs 0·25in. in diameter are standard; then if the diamond wears 0·002in., pegs 0·226 (0·25 $-(6\times0\cdot002\times2)$) are inserted and will bring about the correct adjustment. From the description it will be seen that the pantograph unit is separate from any other part of the machine. It may easily be withdrawn and replaced by another. In general it is found that a pantograph unit will operate for two years or more before it loses accuracy. The makers recommend that no attempt be made to recondition it, but that a new one should be fitted. The pantograph illustrated in Fig. 103 is suitable for pitches from about 16 D.P. to 4 D.P. For coarser pitches one similar in construction, but giving a reduction of only 3 to 1, is used instead. The form plates used with the normal pantograph unit can also be used with that suitable for coarse pitches, but, of course, the size of tooth then produced is altered.

THE INDEXING MECHANISM.

Indexing, as has already been pointed out, is of very great importance when grinding a gear. However satisfactorily the actual teeth may be formed, any divergence from the correct pitch ruins the performance. Indexing on the Gear Grinding Company's machines is performed by a patented mechanism controlled by an index plate mounted at the rear of the workhead spindle. This plate is a wheel of specially close-grained cast iron, having a series of projections on its periphery equal to the number of tooth spaces in the gear wheel to be ground. One side of each of these projections is ground flat to form a radial face, and the pitch of the radial faces is accurate to a cumulative error not exceeding 0·0002in. The work of grinding these faces is per-

formed by the machine illustrated in Fig. 109, the indexing mechanism of which was constructed by Cooke, Troughton and Simms, Ltd., of London and York, the astronomical instrument makers, and adapted for its present use by the Gear Grinding Company. A full description of this machine is impossible in the limited space of these articles, but it will be seen that the accuracy of an ordinary dividing head is amplified by corrections performed by the observation of highly accurately divided scales through microscopes. The method by which one of these indexing plates is mounted accurately and concentrically upon the end of the work spindle can be seen by reference to Fig. 105. It is carried between two opposed cones on the spindle, and its angular position relative to the gear wheel mounted at the front of the spindle may be adjusted by the use of the two screws on the driver plate, to be seen more clearly in the tone engravings, Figs. 106 and 107. These latter engravings show also two stages in the indexing motion from one radial face to the next, while a sectional view of the operating mechanism can be seen in the line engraving, Fig. 108. A spline shaft driven hydraulically, and set in motion either manually or automatically, carries at its upper end a plate upon which is mounted in a bearing eccentrically placed with regard to the plate a specially shaped carrier. A screwed rod connected at the other end with the levers responsible for controlling the movements of the index plate projects through the plain bore of the carrier, and is screwed into a knurled nut which can bear against the face of the carrier. A spring seated against a second projection of the carrier and surrounding the screwed rod tends to force the knurled nut against the face of the carrier. When the indexing motion is started, the spline shaft is given one half a turn of rotation and back, so that the excentrically placed carrier on the plate moves in a semi-circular path and the screwed rod is drawn first outwards away from the machine and then returned towards it. On the outward journey a pawl and an arm immediately above the index plate are drawn back until the pawl drops into position beind the next tooth of the plate—see Fig. 106. At the same time a second pawl, against which the radial faces of the index plate are held by hydraulic pressure when grinding is taking place, is lifted to allow one of the projections of the plate to pass. On the inward journey the index plate is carried round by the first pawl until its next radial face abuts against the second pawl—Fig. 107. The spring in the carrier is provided to give flexibility to the operation and to prevent undue stresses being thrown on any part of the mechanism, while for adjustment of the stroke the plate can be moved relatively to the flange of the spline shaft.

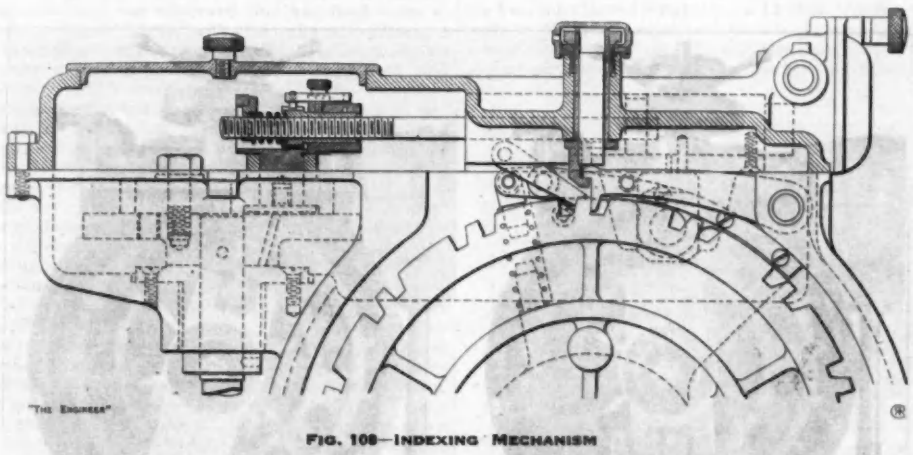


FIG. 108—INDEXING MECHANISM

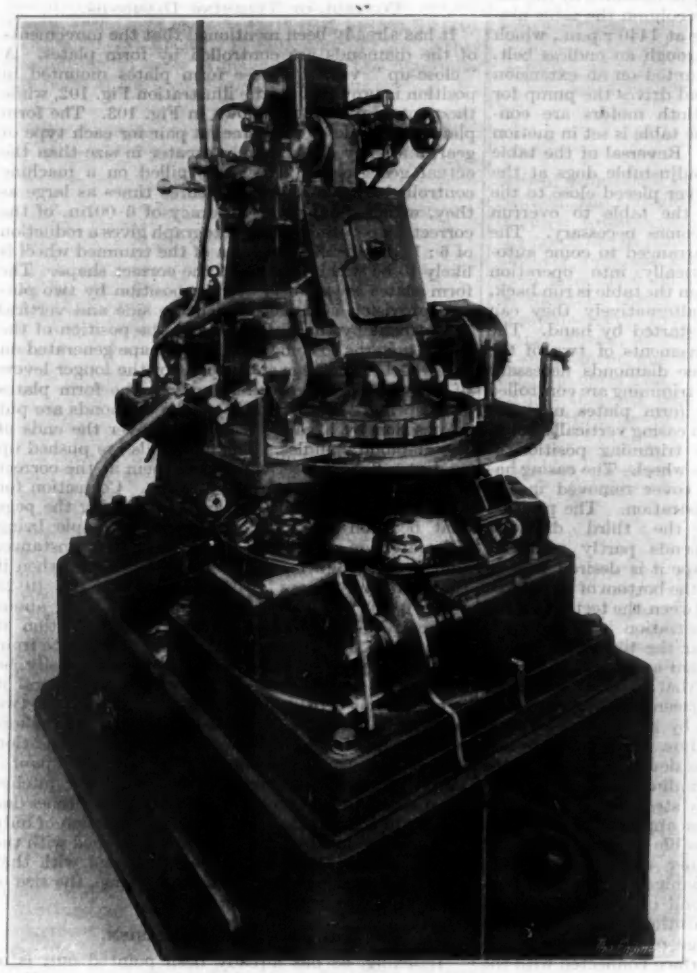


FIG. 109—GRINDER FOR INDEXING PLATES

THE WORK SPINDLE.

The whole work spindle with the indexing mechanism is carried on slides, within a saddle on the top of which the hand wheel for adjusting the cut is mounted. The arrangement can be seen in the line engraving, Fig. 105. When suitable, gear wheels to be ground on this machine are mounted on arbors, which are drawn into the taper bore of the spindle by means of a pull rod, thus avoiding the necessity for any hammering. For small work, however, gangs of gears may be mounted on a mandrel and ground between centres. The second method is particularly applicable to gears less than 3½in. in diameter.

GRINDING INTERNAL TEETH.

A slightly modified machine is used for grinding internal teeth, such as those to be found on the outer wheels of epicyclic gears. The ring is mounted in a specially designed chuck exactly concentric with the spindle, and a small grinding wheel driven from the main spindle by a train of gears is mounted on the grinding head, as shown in Fig. 110. As the spaces to be ground between the teeth of an internal involute gear are shaped like the actual teeth of an ordinary wheel form, plates similar to those used on the ordinary gear grinder may be utilised, but modifications are necessary to the pantograph mechanism. The two form plates are brought very close together, as shown in Fig. 111, and one pantograph and a single diamond are used to form both sides of the wheel. Whereas on the ordinary machine the form plate on the left forms the left side of the wheel, and that on the right the right, the position is now reversed, the plate on the left forming the right of the wheel and that on the right the left. A second manually operated diamond forms the periphery of the wheel. In other respects the mechanism is the same as before. The position of the diamonds is unaltered throughout the grinding operation, and the cut is put on by raising the work; the wheel is lowered for trimming.

All gears that are to be ground must, of course, be cut. Generally, they are also hardened, but where extreme accuracy is required, soft gears are sometimes ground. The amount of stock left for grinding depends to some extent upon the material, since some materials distort more than others in the hardening process. In general, however, a gear cut to a pressure angle from 1 deg. to 2 deg. less than that which it will have when finish ground leaves a suitable amount of stock. For instance, if the finished pair of gears is to have a pressure angle of 20 deg., they should be cut for a pressure angle of 18 deg. or 19 deg. As far as the depth of the teeth is concerned, this is unaffected by the grinding operation, and should be cut to size.

It is of interest, as indicating how the field of use of ground gears is expanding, to find that the Gear Grinding Company, which formerly only made machines for its own use, has now decided to place such machines on the market.

(To be continued.)

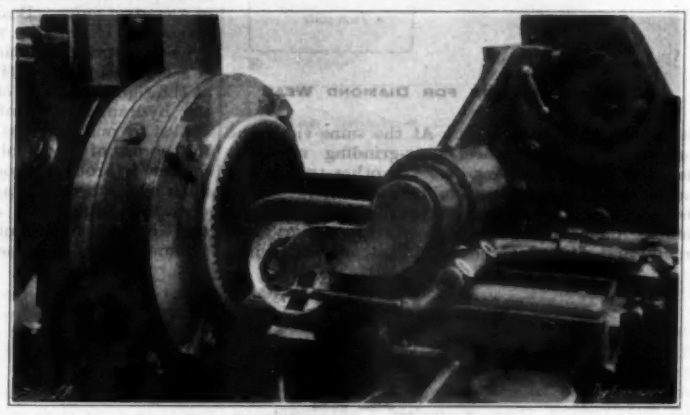


FIG. 110—GRINDING INTERNAL TEETH

FIG. 111—ARRANGEMENT OF FORM PLATES FOR INTERNAL GRINDING

Obituary.

HORACE FIELD PARSHALL.

ELECTRICAL engineers in many parts, and particularly in this country and America, will learn with regret of the death of Dr. H. F. Parshall, which occurred on Monday, December 12th, at Bayonne. Although little has been heard of him during recent years, he was, of course, at one time a very prominent member of the electrical profession, and was responsible for much important electric traction and other work whilst practising in London as a consulting engineer. He was born on September 9th, 1865, at Melford, New York, and was educated at Cornell and other universities, his early practical experience being gained with the Sprague Electric Railway and Motor Company, for whom he designed stationary and railway motors. Subsequently, he became chief engineer to the Wenstrom Dynamo and Motor Company, at Baltimore, where he developed the four-pole, slow-speed, single-reduction motor, which soon met with a wide field of application. Later, he acted as chief designing engineer to the Edison General Electric Company, and retained that position after the consolidation of that concern with the Thomson-Houston Company. During this period there was important progress in the development of what were then considered large electrical machines, such as three-phase generators and rotary converters, whilst progress was also made in the design of the electrical equipment of motor coaches and locomotives.

For some time he was lecturer on dynamo design at the Massachusetts Institute of Technology, and was joint author with Mr. H. M. Hobart of various standard electrical books, the most notable of which were "Armature Windings," "Electric Generators," "Electric Machine Design," and "Electric Railway Engineering." "Electric Machine Design" was a revision and enlargement of the book entitled "Electric Generators," which was an amplification of the notes of a series of lectures given, first by Dr. Parshall, and continued by Mr. Hobart, at the Massachusetts Institute of Technology. There is no doubt that these books proved of great value to students and engineers engaged on electrical work in this country and elsewhere, and that they played an important part in the process of building up present-day practice. From the point of view of real practical value few electrical books of recent origin can equal them, although, of course, they are now out of date.

Electric railway engineering was Dr. Parshall's speciality, since most of his time was devoted to the design of the specific apparatus employed or to installations as a whole, including power-houses, transmission systems, and rolling stock. Whilst in London he acted as consulting engineer to various companies and corporations, such as the Glasgow Corporation Tramways, Dublin United Tramways, Bristol Tramways, London United Tramways, Isle of Thanet Tramways, and the Central London Railway, of which he ultimately became chairman. He was also consulting engineer to the Lancashire Electric Power Company, and was responsible for some of the earliest turbo-generator stations.

Prior to the inauguration of the Dublin United Tramways, rotary converters were seldom met with in Great Britain, but with the opening of the Central London Railway some time later and the increased use of three-phase generators, that type of machine soon attracted considerable attention and was ultimately used in many directions. Unfortunately, the inability of early rotaries to run satisfactorily with 50 cycle current led to the introduction of 25-cycle supplies which are now being abolished at considerable cost, although Lot's-road and other traction stations continue to generate at their original low frequencies. But Dr. Parshall lived to see the 50-cycle rotary brought to perfection and to witness the introduction of the metal-cased rectifier, which he would probably have welcomed in the early days.

JOHN THOMAS WOOD.

WE have to announce with regret that Mr. John T. Wood, chairman of Francis Morton and Co., Ltd., of Garston, until June last, died on December 15th. Mr. Wood was born in 1849 at Aspull, near Wigan, and at eighteen years of age was articled to the late Mr. James Newlands, City Engineer of Liverpool. In 1887 he became Borough Engineer of Cambridge, and after some years relinquished that position to take up private practice in Liverpool, where, later, he was joined in partnership by Mr. John A. Brodie, the late City Engineer and now joint engineer of the Mersey tunnel scheme, which partnership terminated on Mr. Brodie being appointed City Engineer in 1898.

Subsequently, Mr. A. F. Fowler joined Mr. Wood, and they constructed several docks for Laird Brothers at Birkenhead. In conjunction with the late Mr. J. J. Webster, he was engineer for the Transporter Bridge at Widnes, erected in 1904–5.

Mr. Wood, along with several other prominent Liverpool and Manchester gentlemen, purchased the business of Francis Morton and Co., Ltd., in June, 1898, of which company he succeeded as chairman, the late Colonel G. H. Morrison, of Messrs. Turner and Co., Dale-street, Liverpool, in 1901, and continued in that position until June, 1932, when he retired owing to ill health.

He was always greatly interested in farming and agricultural work, and was one of the founders—with the late Lord Derby—of the Royal Lancashire Agricultural Society. He was also a member of the Royal Agricultural Society of England, and was one of a number of delegate British farmers who visited Canada in 1890 at the invitation of the Canadian Government to report upon the agricultural conditions of the Dominion.

He was a member of the Institution of Civil Engineers, and a Past-President of the Liverpool Engineering Society.

FREDERIC JOHN STEPHEN.

THE Clyde shipbuilding industry has suffered a severe loss in the death of Mr. Frederic John Stephen, the chairman of Alexander Stephen and Sons, of Linthouse, Glasgow, which took place at his home, Invergare Rhu, Dumbartonshire, on Friday of last week, December 16th.

Mr. Stephen, who was sixty-nine years of age, was born in Glasgow, and was educated at Glasgow University. Thereafter he attended the classes in naval architecture conducted by Professor Jenkins, and after a period of foreign travel, mainly in the United States, entered the shipbuilding department of the Linthouse shipyard, where he speedily came into prominence as a designer and constructor of ships. In the 'nineties he took over from his father, the late Mr. Alexander Stephen, the main responsibility of the shipyard side of the business, with which he was afterwards actively associated during a period in which a great number of notable ships were built by his firm for both British and foreign owners.

Mr. Stephen took a keen interest in all that pertained to the technical side of shipbuilding, and was associated with many of the technical institutions and societies. He was for some years a member of the Council of the Institution of Naval Architects, and served for a period on the Council of the Institution of Engineers and Shipbuilders in Scotland. He was also a Past-president of the Clyde Shipbuilders' Association. During the greater part of his career he was connected with the British Corporation Registry of Shipping and Aircraft, and as Chairman of its Technical Committee he rendered valuable services, not only to the Registry itself, but also to shipbuilding generally. He was also chairman of the Steel Company of Scotland, Ltd. He was a great Clyde yachtsman, and during half a century was prominent as a designer, builder, and steersman of yachts and a great administrator. His death will be keenly felt in shipbuilding circles, and by those who knew him in his business relations and in the sport which he so dearly loved.

W. C. ULLMANN.

MR. WILLIAM CHARLES ULLMANN, who died suddenly on Wednesday, December 14th, at the age of sixty-eight years, entered the service of the South Australian Government Railway in 1881 as an engineering apprentice, and later became an Inspecting Engineer. In 1889 he came to London as the resident engineer for the Brush Electrical Engineering Company, the contractors for the lighting of the City of London. Six years later he returned to Australia to take up the appointment of chief engineer to the Sulphide Corporation, of New South Wales, but in 1898 joined the British Thomson-Houston Company as resident engineer at Sheffield for the construction of the first sections of the Sheffield Corporation Tramways, and in the following year was appointed engineer and manager of the East Ham Corporation Electricity and Tramways Department. In the last-mentioned capacity Mr. Ullmann designed and constructed the electric lighting and tramways undertakings for East Ham, the tramways being the first municipal electric tramways in the Metropolis. Mr. Ullmann retired from this appointment some years ago. He was a member of the Institution of Mechanical Engineers, of the Institution of Electrical Engineers, and of the Institute of Transport.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

UNEMPLOYMENT AND PROFESSIONAL ENGINEERS.

SIR,—I have read with considerable interest the second leading article appearing in the current issue of your periodical on the topic of the existing unemployment amongst professional engineers, and also among those embryo engineers who have recently left their university or technical school. I take leave, herein, to accept your invitation to put forward a suggestion that may, perhaps, act as a palliative, even though I am unable to make, at the moment, a proposal of a permanent plan to solve a problem which has been left all too long without any apparent attempt to tackle it.

To put the matter quite briefly, I suggest that some form of temporary instructional centres be formed in various parts of the country, in which unemployed civil engineers (also others, if found practicable), would be employed to lecture to those younger members of the profession who have either just left their scholastic training, or who have been on some minor works and who are at present disengaged. Naturally, such lecturers would have to be men of considerable practical experience, and would only speak on such branch, or branches, of work of which they have had actual knowledge, it being borne in mind that such ounces of practice are often worth pounds of theory as expounded by those who, however eminent in their own line, usually cannot know all the "snags" encountered in dealing with contractors and others in different parts of the world, and with the Forces of Nature as met with there. Those wishing to become either lecturers, or student-engineers, could submit their names to a specially appointed staff for investigation.

Coming to what is perhaps the most important aspect of the question, namely, that of remuneration of all concerned in this proposal, it really would seem that if our leading engineering institutions can arrange to circularise members for subscriptions, or donations, to various funds of an obviously lesser importance than the one under present discussion, they can also do so for one of such pressing urgency as the preservation of the body and brains of engineers, both qualified and in the process of becoming so. Such financial aid forthcoming (and it is difficult to believe that it wouldn't be), the arrangement of the relative and actual amounts of the salaries to be paid to both lecturers and to those students who have "no visible means of support," would seem to be a comparatively simple matter.

Lastly, I would like to tender my congratulations to you, Sir, for bringing up a subject of such national importance, and for having mentioned, among other leading points, the fact that many of us have been living on the charity of relatives for some time past now, and that these kind and charitable folk are not only suffering from greatly reduced dividends, but also get no reduction of income tax for their pains; but, then, that is hardly a fit topic for your columns. P. C. RUTHVEN.

Eastbourne, December 10th.

THE FIRST LARGE ELECTRIC LIGHTING PLANT.

SIR,—Colonel R. E. Crompton's account of the first electric lighting of the Law Courts on December 4th, 1882, and his statement that "at that time no one, not even Edison in America, had attempted to produce an installation approaching in size the one at the Law Courts," has caused me to refer to my files. I find that the first Edison central station for incandescent lighting was at Holborn Viaduct, opened for service on January 12th, 1882, just eleven months before that at the Law Courts.

The engineer was Mr. William J. Hammer, afterwards a Vice-President of the American Institute of Electrical Engineers. He had been Edison's assistant at Memlo Park for two years. The Holborn Viaduct station was of 3000-light capacity (as compared with 2000 at the Law Courts), it employed underground conductors, and a metering system. I have seen the fuse or plug used in the circuit. It is in the Hammer collection of historic circuits. The fuse is labelled "Edison safety plug or fuse used in London, Eng., Jan. 12, 1882, to connect the first incandescent lamp ever lit from an Electric Lighting Central Station in the history of the world. Used at Holborn Viaduct (3000-light station).—W. J. H."

Mr. Hammer subsequently had charge of the exhibition of Edison's inventions at the Crystal Palace in 1882, where he installed twelve Edison machines for serving some 2000 Edison incandescent lamps.

After establishing the Holborn Viaduct station Mr. Hammer went to Germany as chief engineer of the German Edison Company, subsequently known as the Allgemeine Elektricitaets Gesellschaft. He served in the Great War as major in charge of electrical and aeronautical industries on the General Staff of the U.S.A. Army War College.

Without detracting from the great merit of Colonel Crompton's pioneering work in those early days, it is as well to record the facts and dates of the Edison enterprises in England, and to render this slight homage to the genius of Mr. Hammer. DUDLEY W. WALTON.

Teddington, December 17th.

THE BOILERS IN BOW POWER STATION.

SIR,—In your issue of the 2nd inst. you make reference to the lamented death of Mr. W. H. Patchell and mention the interesting fact that Mr. Patchell installed at Bow upright boilers, which, at the time, were said to be the largest in existence.

In view of the considerable developments which have since taken place, you may like to know that one of our active directors, Mr. A. R. Bellamy—who was a friend of the late Mr. Patchell—was a director of Messrs. R. Hornsby and Sons, Grantham, at the time his firm supplied the boilers in question. RUSTON AND HORNSBY, LTD.,
J. A. WALKER,

Lincoln, December 13th.

ALTERATIONS of the piers at North and South Queensferry have enabled the L. and N.E. Railway ferry service to be independent of the tides.

Recent Progress of the Oil Locomotive.

(From a Correspondent.)

THE recent expansion of oil engine traction in Russia and the Far East, together with the attention given to this important subject at the York meeting of the British Association, make apropro a brief review of the latest practice.

JAPAN.

Following the successful operation of the 2–6–2 oil-electric locomotive built in 1929, there has been a rapid development in Japan, eleven 600 B.H.P. units being now in traffic, ten of them being provided with electric transmission. All are similar to the 1929 machine, with a large double-armature motor driving the wheels through a geared jack shaft and rods. The sound mechanical design of these locomotives may be examined in Fig. 1, which shows the general arrangement of the first vehicle. The descriptive particulars are well known and need not be repeated here.

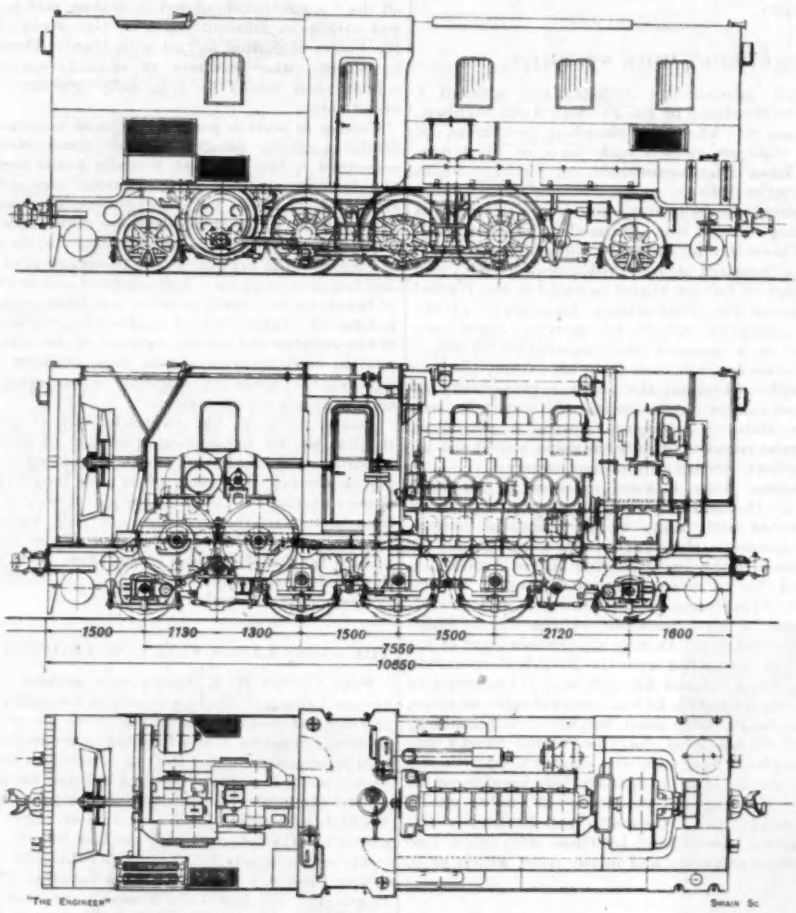


FIG. 1—JAPANESE OIL-ELECTRIC LOCOMOTIVE

For purposes of comparison the 600 B.H.P. geared locomotive shown in Fig. 2 has been constructed. The mechanical portion is much the same as that of the oil-electric locomotives, the main difference being the removal of the cab to one end. Contrary to what would be expected, the geared is the heavier of the two types. Practically all the difference is made up in the prime mover, for the 600 B.H.P. M.A.N. engine incorporated in the electric machines has been replaced by a supercharged engine of twice the weight.

Krupp's were responsible for the complete locomotive, and as far as the transmission was concerned drew largely upon their experience in constructing the gear-box for the Lomonosoff 1200 B.H.P. locomotive. Compared with that machine there are two main differences. The magnetic main clutch has been replaced by a hydraulic system, which in normal working is coupled mechanically, the oil only coming into use during a gear change. Secondly, the prime mover of the Soviet locomotive is reversible, while in the Japanese locomotive reversing is effected by a supplementary shaft in the gear-box. In both machines the gear-box clutches are of the magnetic type. From the 17 seconds of the Russian locomotive, the time for a complete gear change has been reduced to 5 seconds, and tests have shown this period to be sufficient to prevent shocks to the couplings on the train.

The small number, and the value, of the speeds provided seems to be open to criticism. With a rated engine speed of 540 r.p.m. the three-speed gear-box gives train speeds of 6½, 15½, and 37 m.p.h., the last-named being somewhat high for a shunting locomotive, even when running light. Intermediate speeds are obtained by regulating the revolutions of the main engine, and it was probably for this reason that the Krupp engine was preferred to others whose speed and power ranges were not so great.

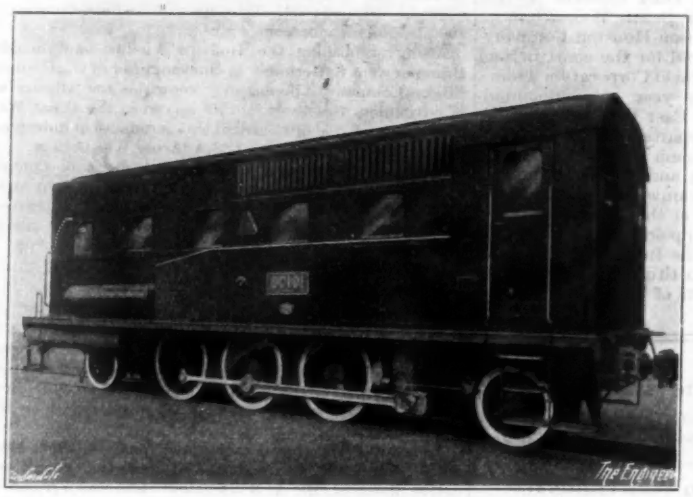


FIG. 2—JAPANESE OIL-MECHANICAL LOCOMOTIVE

RUSSIA.

The designs of the later Russian locomotives have been derived directly from the experiences gained with the two machines of 1924–5. In the latter year Professor Lomonosoff laid down certain points which were to be specified for all future oil-electric locomotives, and these improvements are embodied in the 1200 B.H.P. locomotive to his design which has recently been set to work. They comprise, mainly, a flexible coupling between the main engine and generator; separately driven pumps for the cooling water and piston cooling oil; and forced ventilation for the traction motors.

In this latest 4–10–2 locomotive the M.A.N. engine is virtually duplicate with that of the 1200 B.H.P. Diesel-mechanical unit. Electric braking is provided and is operated from a separate controller in the cab, but for reasons of expense and weight it will not be fitted to the locomotives now being erected at Kolomna. The cooling system is that devised by Professor Lomonosoff after the arrangement (which included a cooling tender) fitted to the first locomotive had proved unsatisfactory. In the present lay-out—which has been adopted for all the Soviet engines between 300 and 1500 B.H.P.—the cooling elements are mounted on the end of the locomotive; a separately driven Betz fan pulls air through the radiator bank and ejects it upwards through a specially shaped trunk.

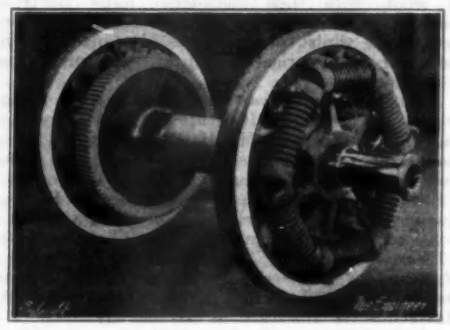


FIG. 3—SECHERON AXLE DRIVE

Standardisation has been studied in the 600 B.H.P. 2–8–0 and 2–8–2 locomotives turned out in March and November, 1931. The motors of the former are duplicate with those of the 1200 B.H.P. locomotives, although four of them are much above the oil engine's capacity, while the main generator and auxiliary apparatus are the same as those of the 2–8–2 machine. Both types have a high-speed M.A.N. engine similar to those used in Japan and Manchuria. Some difficulty was at first experienced in burning "mazout" in these engines, although no trouble was forthcoming in the 1200 B.H.P. units. "Mazout" is the coarse fuel resulting from the distillation of benzine and lubricating oil from the ordinary Caucasus fuel oil. After various adjustments a satisfactory method of burning this fuel was attained, and it is now universally used for the Russian oil locomotives, all of which are working east of the Caspian Sea. Non-stop runs up to 110 miles in length have been made in freight service by the 2–8–0 locomotive, brief particulars of which will be found in Table I.

The Secheron individual axle drive (Fig. 3) has been used to transmit the torque of the six double-armature motors of the 1500 B.H.P. locomotive delivered to the Soviet Government some five months ago. Only the 17ft. height of the Russian loading gauge permits the application, which is unique among oil-electric loco-

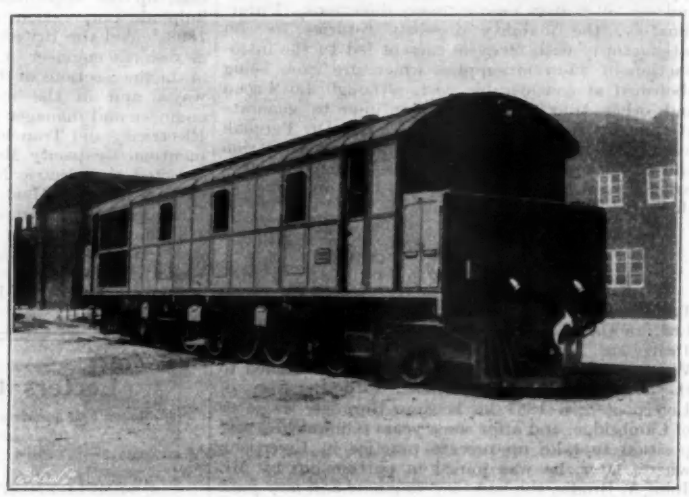


FIG. 4—SIAMESE OIL-ELECTRIC LOCOMOTIVE

motives. A double power plant, consisting of two 750 B.H.P. Sulzer engines, is incorporated, but the cooling and auxiliaries are generally as in the new 1200 B.H.P. locomotive. On test the engines showed their ability to maintain 825 B.H.P. for over an hour, and a maximum for ten minutes or so of 860, so it would appear that liberal rating has been carried a stage too far Although this locomotive, which is to the design of N. Dombrovolski, was ordered in 1927 along with the last-described 1200 B.H.P. machine, delivery was much delayed by the political unrest in Russia, which resulted in the oil locomotive department having a chequered career.

As mentioned in THE ENGINEER for January 29th last, the Soviet authorities did not even contemplate electric transmission for sizes round 300 B.H.P., and in consequence of this policy a four-speed gear-box has been fitted to the new shunting locomotives. The principles of the Lomonosoff and Japanese oil-mechanical units have been forsaken for yet another clutch arrangement, and the torque of the 300 B.H.P. M.A.N. engine is transmitted through a spring clutch, while the gear-box clutches are of the multiple-disc type, actuated by pneumatic cylinders to which compressed air is led through fixed piping. In order to avoid a break in tractive effort during a gear change one of the gear clutches begins to engage before the other is completely disengaged. Reversing of the locomotive is effected by two loose bevels on the first transverse gear shaft, to which they can be coupled by means of a clutch operated by oil under pressure.

SIAM.

There is no doubt that the oil-electric locomotives sent out to Siam at the end of 1931 by Frichs have done exceedingly well. It is too early to make any statements as to maintenance costs, but their introduction has enabled the authorities to accelerate and improve the services and allowed them to reduce the fares on one section. The 4–8–4 engines (Fig. 4) have been working the Southern expresses since their inception, and one of them has run right through to Singapore for the edification of the Federated Malay States Railway officials, who are closely watching the performance. Trailing loads up to 420 tons have been handled on the express schedule, and a weekly mileage of 2400 has been maintained by some of the machines.

The satisfaction given by these locomotives can be traced to the same root that has led to the success of main-line oil traction in Russia, Denmark, and the Argentine—that of having locomotive and railway men fully responsible for all phases of the design. Frichs build the engine and mechanical portion in the same factory, but they have realised that this of itself is not sufficient, and have placed railway men in full control.

An interesting sidelight is thrown on the remarks of various speakers at the recent British Association meeting by these Siamese engines. During the discussion on Oil Engine Traction, it was suggested that for main line work the cost of an oil locomotive was some two and a half times that of an equivalent steam engine, while an exponent of the new vehicles said that the cost was not twice, but he was very careful to state that that was so only on the (debatable) assumption that a smaller number of oil locomotives was required, and the cost taken over the lot. The actual price of one of these Siamese locomotives was 3·64 times that of the "Pacifics" which previously worked the trains, and the high price cannot be excused on the score of only "one off," for six were ordered at the same time.

Sir Henry Fowler rightly criticised one speaker's figures for the cost of steam locomotives. He might well have done the same to the values suggested for oil-electric locomotives. The railway management which was offered a 2000 B.H.P. oil-electric locomotive for £26,000 would probably close the bargain at once, unless the design was a freak, for purchasers have been accustomed to receiving offers of locomotives of half that power at only 10 to 15 per cent. less cost. A 1200 B.H.P. oil-electric locomotive for main line goods work was recently offered at £23,000, whereas the "Consolidations" which now do the work cost roughly £6400 each for ten off. It is only reasonable to suppose that an order for ten oil-electrics would bring the price down to £20,000, but there would still be much to cavil at. This is not an isolated case. The price of some 1000 B.H.P. passenger locomotives lately set to work abroad was within £200 of that of the oil goods locomotive just mentioned. But it is impossible to get at the true cost, for, consequent upon bad trade conditions, the practice has grown up of taking an oil locomotive order at a loss in order to "get in," and reap a problematical harvest when the tide turns.

On the north lines the Siamese 1500 B.H.P. goods locomotive is running in competition with the 2–8–2+2–8–2 "Garratts." At the full normal rating the rail horse-power approximates to that of the steam machines, which have shown their ability to maintain 1100 R.H.P. at speeds up to the maximum allowed, viz., 28 m.p.h. Considering that both passenger and goods locomotives possess a double power plant, the values for unit weight (Table I.) may be reckoned satisfactory, but in each case the bogie wheels are loaded to over 85 per cent. of the driving wheel load. Roller bearings are fitted to all boxes.

DENMARK.

The two 4–8–4 locomotives of the Danish State Railways have prime movers the same as those of the Siamese express units, but, despite a greater permissible axle load, it has not been found possible to reduce the number of axles. Consequently, the unit weight is a little higher than the value for the Oriental machines, although showing a great improvement on the earlier 450 B.H.P. locomotives of the Danish State Railways. These units have been in service barely twelve months, but already the results have confirmed the five years' successful work of the 200 to 450 B.H.P. locomotives, and the State Railways' officials have announced that no further steam locomotives will be built. At the present time Frichs have in hand, or have just completed, twenty-five oil-electric locomotives for various Danish lines, the total B.H.P. being over 6600.

FRANCE AND SWITZERLAND.

Elsewhere on the Continent, the Ceinture Railway of Paris is putting into traffic a 2–8–2 locomotive. As the tractive effort is sufficient to start a 475-ton train on a 1 in 80 gradient, it is presumably intended for goods working, and pulling International trains round from one terminus to another, and not to run in competition with those curious 4–6–0 tandem-compound tanks which haul the light passenger trains. The eight-cylinder Sulzer engine is rated at 800 B.H.P., evidence of a brightening up following the tests of the Russian 1500 B.H.P. locomotive, for the engine is that normally rated at 750 B.H.P.

For many years these engines have been rated at the absurdly low brake M.E.P. of 66 lb. to 68 lb. per square inch, but recent tests have demonstrated their ability to work almost continuously at a power some 12 per cent. above the rating without any change in design. No evidence is forthcoming that this "easy yoke" has made them more reliable than certain other makes of lesser weight and higher pressures, and in the matter of fuel consumption the comparative tests on the South Manchurian Railway have shown them up to advantage only under full-

TABLE I.—*Leading Characteristics of Recent Oil-Electric Locomotives.*

No. off.	First built.	Railway or owners.	Gauge.	Service.	Wheel arrangement.	Engine B.H.P.	Engine r.p.m.	Max. T.E., lb.	Max. speed, m.p.h.	Weight in working order, tons.	Weight per B.H.P., lb.
1	1930	Danish State	4′ 8½″	Passenger	A2–1A	450[1]	600	?	?	58·5	291
5	1930	U.S.A. (various)	4′ 8½″	Shunting	B_o–B_o	400	900	42,000	40	62	350
2	1930	Canadian National	4′ 8½″	Shunting	B_o–B_o	400	900	42,000	40	62	350
1	1930	Westinghouse Company	4′ 8½″	Shunting	B_o–B_o	800[2]	900	66,000	45	98	275
1	1930	Baldwin Locomotive Works	4′ 8½″	Shunting	B_o+B_o	1000[3]	500	67,500	25	120	268
2	1930	N.W.R. (India)	5′ 6″	Light passenger	B_o–B_o	350	900	10,250	60	48	370
45	1930	New York Central, Ill. Cent., and D.L.W.	4′ 8½″	Shunting	B_o–B_o	300[4]	550	60,000	28	114	850[5]
1	1930	C.M. St. P. and Pacific	4′ 8½″	Shunting	D_o	600[2]	?	48,000	25	71·5	267
1	1931	South Manchurian	4′ 8½″	Shunting and goods	B_o–B_o	750	650	35,700	37	80·5	240
1	1931	South Manchurian	4′ 8½″	Shunting and goods	B_o–B_o	700	700	35,700	37	72·45	232
3	1931	U.S.S.R.	5′ 0″	Goods	1–D_o–0	600	700	46,000	34	93·5	350
1	1931	U.S.S.R.	5′ 0″	Goods	1–D–1	600	700	35,250	31	97·5	364
1	1931	Switzerland	4′ 8½″	Mixed	1–C_o–1	700[6]	800	?	?	64	205
1	1931	Siamese State	Metre	Heavy goods	2–D_o–D_o–2	1500[7]	600	63,000	28	124	185
6	1931	Siamese State	Metre	Express passenger	2–D_o–2	1000[8]	600	32,000	42	85	189
6	1931	Siamese State	Metre	Mixed	A1A–A1A	450	700	20,700	42	59	294
2	1931	Danish State	4′ 8½″	Express passenger	2–D_o–2	1000[8]	600	37,500	70	100	224
1	1931	Denmark (private)	4′ 8½″	Passenger	A1–1A	350	600	?	37	43	276
1	1931	Consolidated Diamond Mines	2′ 0″	Goods	A1A–A1A	300[6]	700	?	22	55	411
3	1931	Port of Rosario	5′ 6″	Shunting	B_o–B_o	330	700	30,800	28	57·5	390
7	1931	Bush Terminal	4′ 8½″	Shunting	B_o–B_o	300	550	30,000	28	53·5[9]	400
1	1931	Erie R.R.	4′ 8½″	Shunting	B_o–B_o	800	550	57,000	25	102·5	288
1	1932	U.S.S.R.	5′ 0″	Heavy goods	2–E_o–1	1200	400	44,100	34	135	252
1	1932	U.S.S.R.	5′ 0″	Heavy goods	2–E_o–1	1500[8]	650	57,200	37	144·3	216
9	1932	Japanese Government	3′ 6″	Shunting and goods	1–C–1	600	700	24,000	37	60	224
1	1932	Armstrong-Whitworth	4′ 8½″	Shunting	C	250	775	24,000	30	40	358
1	1932	P.L.M.	4′ 8½″	Shunting	B_o–B_o	750	650	?	34	?	?
1	1932	P.L.M.	4′ 8½″	Shunting	B_o–B_o	600	700	?	34	71·5	268
2	1932	Denmark (private)	4′ 8½″	Light passenger	1–A1A–1	330	650	?	46	44	299
6	1932	Denmark (private)	4′ 8½″	Light passenger	1–C_o–1	415	600	16,000	50	43	232
1	1932	Ceinture (Paris)	4′ 8½″	Mixed	1–D_o–1	800	700	28,000	?	84·5	237
3	1932	B.A.G.S.R. (Argentine)	5′ 6″	Suburban passenger[7]	1A–2+2–A1	1700[8]	550	—	56	130	171
1	1932	B.A.G.S.R. (Argentine)	5′ 6″	Passenger and goods	1A–B_o+B_o–A1	1700[8]	550	35,000 66,000	70 40	148	195
1	U.C.	Armstrong-Whitworth	4′ 8½″	Mixed	1–C_o–1	800	700	22,000	65	73	205
3	1932	Ford Works	4′ 8½″	Shunting	B_o–B_o	150	550	?	?	40	600
10	U.C.	U.S.S.R.	5′ 0″	Heavy goods	2–E_o–1	1200	400	44,100	34	133	250

[1] Two-cycle engine. [2] Double power plant. [3] Supercharged. [4] Oil-electric battery locomotive, 1600 H.P. ext. supply. [5] On basis of engine power. [6] Overhead line also. [7] Mobile power-house. [8] Mech. portion all-welded.

TABLE II.—*Leading Characteristics of Oil-Mechanical Locomotives.*

No. off.	First built.	Railway or owners.	Gauge.	Service.	Wheel arrangement.	Engine B.H.P.	Engine r.p.m.	Maximum T.E., lb.	Maximum speed, m.p.h.	Weight in working order, tons.	Weight per B.H.P., lb.
1	1925	U.S.S.R.	5′ 0″	Heavy goods	2–E–1	1200	450	43,000	31	129	241
2	1927	Siamese State	Metre	Shunting	B	200	500	11,500	25	23·5	263
1	1929	B. San Paulo	Metre	Shunting	B	150	900	9,240	15	17·3	258
1	1929	Junin (Chile)	2′ 6″	Shunting	1–C–1	330	1000	?	?	32	218
1	1931	Boston and Maine	4′ 8½″	Freight	2–D–2	1,450[1]	470	50,000	?	145·5	225
1	1931	Japanese Government	3′ 6″	Shunting	1–C–1	600[1]	540	26,400	37	65·5	244
1	1931	Japanese Government	3′ 6″	Shunting	B	150	900	14,520	9·5	33	493
1	1931	Hudswell-Clarke	4′ 8½″	Shunting	C	150	900	9,570	30	19	284
1	1932	U.S.S.R.	5′ 0″	Shunting and goods	B	300	700	22,000	22·6	37·5	280
1	1932	Morocco	600 mm.	Mixed	1–C–1	150	900	8,150	16	18·6	278
1	1932	L.M.S.R.[2]	4′ 8½″	Shunting	1–C–1	400	750	?	25	46·1	258

[1] Supercharged. [2] Rated power not yet developed. [3] Hydraulic transmission.

load conditions. As locomotives usually work a good way below this rating, an engine is required which will be economical at high fractional loads.

Over 35 miles out and home of level lines, the power developed on these Manchurian trials was 60 to 65 per cent. of the rating, the Sulzer engine showing a consumption of 0·554 lb. per B.H.P. hour, and the M.A.N. unit 0·498 lb. Trailing loads averaged 640 tons, and the speed 16 to 18 m.p.h., the top value being 32 m.p.h. The Sulzer locomotive labours under the disadvantage of 8 tons extra weight without any corresponding gain in tractive effort. Special tests to determine the fuel consumption at various outputs gave the following figures :—

	Fuel Cons., lb. per B.H.P. hour.	
	Sulzer.	M.A.N.
Full load	0·390	0·401
75 per cent.	0·399	0·390
50 per cent.	0·448	0·410
25 per cent.	0·618	0·502

The P.L.M. locomotives, one of which incorporates an M.A.N. engine, and the other a Sulzer, are understood to have been delivered, but no particulars are available. Experiments on the 2–6–2 supercharged locomotive in Switzerland still continue. Results are not known, but in power-weight characteristics

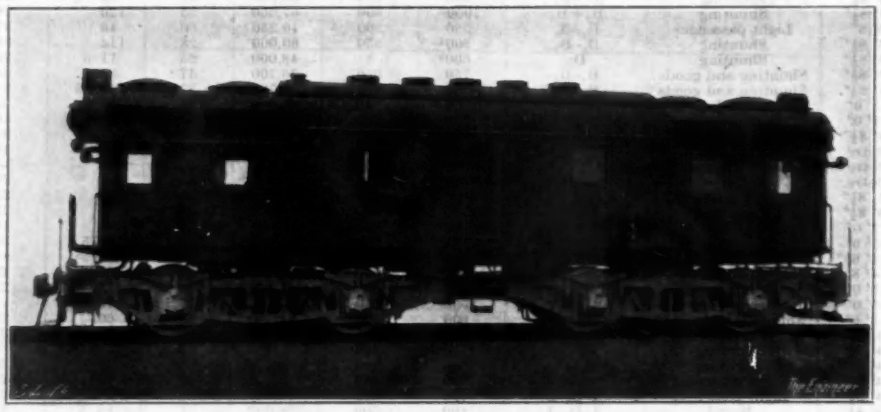


FIG. 5—AMERICAN SHUNTING LOCOMOTIVE

the machine shows some startling figures. Developing, with a Büchi supercharger, 700 B.H.P. at 800 r.p.m., the engine is of the six-cylinder four-stroke type, using air injection, and together with its auxiliary equipment, weighs 38 lb. per B.H.P. By some means or other, not yet divulged, the electrical transmission, including three nose-suspended motors, has been brought down to 48 lb. per B.H.P., against the 60 lb. to 80 lb. of recent normal designs.

AMERICA.

Delivery of the Boston and Maine oil-mechanical locomotive, ordered in Germany five years ago, has not yet been effected. In the earlier stages the unfamiliarity of Continental builders with American locomotive details occasioned some delay, but the root of the trouble is that the stipulated brake horse-power of 1450 has not yet been obtained, despite the inclusion of a supercharger. Several trips have been made within the last seven or eight months, and have apparently been successful within the reduced power limit.

It may be asked of what use is 1450 B.H.P. on an American railway, and this question certainly reiterates the doubts expressed as to the utility of the New York Central 800 and 900 B.H.P. locomotives. The United States has lately slowed up in the production of new designs, but the problem of a high-power locomotive to suit the peculiar conditions will soon have to be tackled, and something vastly in advance of the present-day oil engine will be found necessary.

The 1000 B.H.P. Baldwin-Krupp locomotive (Fig. 5) has covered over 15,000 miles in yard and local freight service on six roads and in open mine haulage, the total working period being some 4000 hours. The supercharger, which is similar to those included in the Japanese and Boston and Maine locomotives, and which works at a normal pressure of 6 lb. per square inch, has not been free from maintenance trouble. After 2500 hours' operation, the main engine was opened up, and the wear on the cylinder liners found to be 0·003in. This is much greater than in the Ingersoll-Rand 300 B.H.P. engines, the wear in which has averaged from 0·002in. to 0·0045in. per 10,000 hours' service, although the percentage of time on full load is probably greater. The high liner wear of the Krupp engine may be due to lack of lubrication, as the figures given for the lubricating oil consumption are suspiciously low at 0·81 gallons per 2000 horse-power hours, or only 0·8 per cent. of the fuel consumption of 0·465 lb. per B.H.P. hour.

GREAT BRITAIN.

The British firm which, two years ago, wedded itself solely to electric transmission, has now a couple of rivals. The 250 B.H.P. shunting locomotive built by Armstrong-Whitworth was illustrated in the issue of THE ENGINEER for June 17th last, and in the first four months of its service in various L. and N.E.R. goods yards, put in 2265 hours of work. The single motor rod-drive of this machine has been given up in favour of nose-suspended motors in the 800 B.H.P. unit under construction at the works of the same builders. Intended more or less for mixed traffic work, the designers have done well to avoid the double-bogie lay-out, and if the final weight comes out anywhere near the anticipated figure of 73 tons, quite a good power-weight ratio will result. The main particulars of the Argentine 1700 B.H.P. mobile power-houses and locomotive, the first of which has just been shipped to Buenos Aires, will be found in Table I. The three B.T.H.-Allen-Metro-Vick locomotives for the Ford works are now completed, but their power is too small and their dimensions too large for any problems to arise in operating or design. The only remaining oil-electric activity of any note is the 270 B.H.P. Harland-Burmeister two-cycle mixed traffic locomotive, now in the first stages of construction for the Belfast and County Down Railway.

Leading particulars of the various geared locomotives constructed since 1924 are given in Table II., but there may be chronicled the advent on the L.M.S. of a 400 B.H.P. hydraulic-drive 2–6–2 shunting locomotive, whose characteristics are, for convenience, included in Table II. In view of the invariable failure of the many preceding hydraulic units, the operating results of this machine will be awaited with much interest.

Electricity Supply.

THE twelfth Annual Report of the Electricity Commissioners covering the year April 1st, 1931, to March 31st, 1932, shows that notwithstanding the widespread depression in industry and commerce, which continued throughout the year, and despite the financial crisis of the autumn of 1931, which resulted in the suspension of the gold standard by Great Britain, there was a continued expansion of the public supply of electricity. While the undertakings in the regional areas of Central Scotland and North-East England again showed a decline in output, the operations of the undertakings in the remaining portions of Great Britain showed a gross increase in units generated of about 641 million, or about 6·9 per cent. on the output in the same portions of the country in the previous year. Even when allowance is made for the falling off of about 104 million units in the output in Central Scotland and North-East England, the electricity supply industry was still able to show a net increase of 537 million units generated, representing a growth of nearly 5 per cent. on the output in the previous year. During each of the past two years of abnormal depression in industrial conditions, the supply industry has thus shown an expansion of output at the rate of over 500 million units per annum. Notwithstanding the continuance of the severe industrial depression throughout the year ending December 31st, 1931, the sales of electricity by authorised undertakers showed an increase of over 356 million units, or upwards of 3·9 per cent. as compared with the figures for 1930. On the basis of the 1931 census of the total population of Great Britain, the sales of electricity from public sources of supply in that year represented an average consumption of 210 units per head of population.

The Report goes on to explain that as the generation of electricity becomes concentrated in a limited number of selected stations, operated under the direction of the Central Board, the great majority of authorised undertakers will be in a position to concentrate their efforts entirely on the equally essential operations of distribution and the commercial development of electricity supply. There has been a widespread extension of distribution areas since the war, and practically the whole of Great Britain is now covered by supply powers with a corresponding increase in the obligations of and opportunities open to the supply industry.

On the technical side, it is explained, it is obviously desirable that the co-ordinated system of generation at a standard frequency under the direction of the Central Board should find its counterpart as soon as possible in a standardised system of distribution, or, at any rate, in the case of the undertakings which derive their bulk supplies directly from the "grid." The official statistics of the Commissioners for 1930–31 show that 253 undertakings were distributing A.C. only ; that 288 undertakings were distributing both A.C. and D.C.; that 121 were distributing D.C. only ; and that there were as many as 45 different declared voltages between the range of 100 and 480 at which supplies were being given to consumers in various parts of the country. The predominating pairs of related voltages in the case of A.C. supplies were 230 and 400, and for D.C. supplies 230 and 460. The former pair of voltages apply to 314 undertakings and the latter to 110 undertakings. The Commissioners have consistently advocated and encouraged the standardisation of distribution as far as it is economically practicable on the basis of three-phase, 50-cycle current, with declared voltages of 230 and 400, and although a considerable measure of response has been forthcoming from undertakers during the past twelve years, there is still much scope for the improvement and standardisation of many more of the present systems of supply.

On the commercial side it is not surprising to find that there are considerable differences in the various parts of the country in the degree of development attained, and in the nature and extent of the facilities and service offered to existing and potential consumers, particularly when it is remembered that the supply industry comprises upwards of 600 separate undertakings of all sizes, some long-established and others only beginning to operate. The course of future development in the different areas of supply is dependent upon a variety of factors, including the financial and other resources of the undertakings concerned and the capacity and enterprise of the management and operating staff. In no case, even among the best developed areas, can it yet be said that the saturation point of economic electrical development is in sight of attainment, and the Commissioners suggest that all undertakers should take an early opportunity of reviewing their policy, organisation and methods, with the object of providing the public with a still better service than hitherto.

The total output of the supply industry in 1931–32, namely, about 11,609 million units generated, accords very closely with the output of about 11,500 million units generated, forecast by the original curve of growth for the country as a whole, prepared by the Commissioners in the latter part of 1926. On the other hand, the total output has not attained to the aggregate shown by the summation of the individual curves of growth adopted in connection with each of the regional schemes and based on the available statistics and estimates of the rate of future growth for the separate undertakings in the respective regions. Unlike the original 1926 curve, which was based on official statistics up to 1924–25, the estimates for the latter curves were prepared in consultation with all the principal undertakers concerned and reflected their anticipations of the course of development of their undertakings under normal conditions of trade and industry, and showed somewhat larger average rates of increase than that on which the original curve for the country as a whole was based.

The Commissioners very naturally point out that the early approach of a period of acute industrial depression which was to last for more than two years could not be foreseen when the estimates for the respective schemes were prepared and the events that have happened have naturally affected the course of electrical development. In place of an annual increase of between 400 and 500 million units in the sale of electricity for power purposes—representing the average growth in the power load during the last decade, apart from the two years in which there were prolonged coal strikes—the supply industry experienced an actual decline of 37 million units in the sales of electricity for power purposes in 1930–31, as compared with the sales in 1929–30, and it will probably be found when the detailed figures for 1931–32 become available that there was a further decline in that year also. In the case of regional schemes for the whole of England and Wales with the industrial belt of Central Scotland, covering nearly 98 per cent. of the population of and output of electricity in Great Britain, the forecasts of aggregate units generated from the public supply stations for the three years 1929–30 to 1931–32 inclusive and under ordinary conditions of development were 10,550, 11,610, and 12,670 million units respectively, whilst the realised outputs in these regional areas were 10,460, 10,814, and 11,307 million units, so that the actual output in 1931–32, after two years of increasingly adverse industrial conditions, fell short of the forecast by about 10 per cent. The difference is substantially accounted for by the loss for two consecutive years of the annual increment of power load which the supply industry might reasonably have expected to obtain but for the acute and prolonged industrial depression.

The aggregate capacity of the generating plant for new stations and extensions of existing stations sanctioned by the Commissioners during the year 1931–32 amounted to 153,238 kW, as compared with 892,249 kW in the previous year. Nine consents were issued in respect of new generating stations representing an initial total capacity of 61,387 kW. The principal consent authorised the establishment by the Swansea Corporation of a new generating station at Tir John North, Swansea, where two 30,000-kW, 33-kV machines are to be installed. The sanctioned extensions to existing stations represented in the aggregate a plant capacity of 91,851 kW, as compared with 892,077 kW in the previous year. The Commissioners again dealt with a large number of applications for the establishment or extension of main transmission lines by the Central Board for the purpose of the new regional schemes and by other authorised undertakers for bulk supply developments. In all, 127 consents were issued, the largest number recorded in any year.

EXPERIMENTS have been carried out in Amsterdam in Holland with a new road surfacing material composed of powdered rubber mixed with asphalt. A special process for producing powdered rubber has been developed there. It is claimed that the new compound provides a noiseless, non-skid surface and that any roads so surfaced can carry traffic within an hour of the application.

Railway and Road Matters.

THE Committee stage on the London Passenger Transport Bill in the Commons was completed on December 13th.

IT is announced that Mr. G. Ellson, chief engineer of the Southern Railway, has been appointed chairman of the Railway Companies Civil Engineers' Committee at the Railway Clearing House for the year 1933.

FROM information given by the railway companies to the Ministry of Transport it appears that 247 track miles are now laid with steel sleepers. That represents about 0·7 per cent. of the total length of line expressed as single track and exclusive of sidings.

ANSWERING a question by Mr. Bryce on Monday last, the Parliamentary Secretary to the Ministry of Transport said that the detailed representations on the part of a large number of bodies and interests concerned in the Salter report were being examined, and the Government would lose no time in arriving at a decision in the matter.

IN THE ENGINEER of December 2nd appeared a short notice of a students' edition of Mr. G. V. O. Bulkeley's book on "Railway and Seaport Freight Movement." At the time our review was written the author was the port manager of the Kenya and Uganda Railways, but has now been made general manager of the Nigerian Railways.

MENTION was made herein on September 16th of some improvements that were to be made to the piers of North and South Queensferry that would allow the London and North-Eastern ferry service across the Forth between those points to run at fixed times. The work has now been completed, and the revised ferry service came into operation on Monday, the 19th.

THE threatened railway strike in Northern Ireland has been averted by the action of the Minister of Labour, who has succeeded in persuading the companies to submit a fresh proposal to the Irish Wages Board. Meanwhile, the companies will retain the present rates of pay until January 23rd. In the Free State, as we stated last week, the Government is subsidising the railways until April 30th.

ASKED on December 12th as to whether the Minister of Transport would consider the formation of a National Transport Board, as recommended in the Minority Report of the Royal Commission on Transport, with a view to solving the economic problem of road and rail competition, the Parliamentary Secretary to the Minister said that the Government were not prepared to favour nationalisation of the means of transport as suggested in the Minority Report.

HAVING regard to the support we consistently gave to the Railway Executive Committee during the war, and up to the time it was disbanded by Sir Eric Geddes on the formation of the Ministry of Transport in 1919, we find satisfaction in Mr. Walkden, of the Railway Clerks' Association, telling the National Wages Board on December 13th that "there was no better work done during the war than the control of the railways by the Railway Executive Committee."

THE Standing Committee on Mineral Transport, which was set up as a result of the Samuel report, continues its activities. The standardisation and pooling of railway wagons is one of the subjects under their care, and, in relation to standardisation, they have recommended the Minister of Transport to issue an Order that for the time being no further mineral wagons of a capacity of less than 20 tons should be constructed without permission. Mr. Pybus is obtaining the views of the railway companies on the subject.

YEAR after year, at about this period, it has been our pleasure to wait upon the chief engineers of the different railway companies to get some particulars as to their activities during the year for notice in our annual article on Railway Engineering. Whilst it is the chief engineers whom we always see, it is mainly upon their respective new works engineers that the compilation of the facts rests. It came, therefore, as a great shock when we saw Mr. R. Carpmael, the Great Western chief engineer, on the morning of Wednesday, December 14th last, to hear that Mr. E. G. Matheson, his new works assistant, had died the previous day. Mr. Matheson had had considerable experience in railway construction, since he joined the Great Western in 1905, including the rebuilding and enlargement of Snow-hill Station, Birmingham, when, in 1922, he became assistant divisional engineer, Bristol. In 1924 he was made the engineer for that division and came to the head offices at Paddington in 1926, and succeeded Mr. W. A. Cashman, as new works assistant, in 1929.

THE former Midland Railway Company reached Manchester originally by a line from its then terminus at Rowsley to New Mills, where it joined the Manchester, Sheffield, and Lincolnshire branch from Hayfield, which branch then became jointly owned. A connection to Buxton was made off the Rowsley–New Mills line, and opened on June 1st, 1863. The London and North-Western entered Buxton on the north side by a line from Whaley Bridge, which was opened on July 1st, 1863. Each company had its own station, but the two lines are connected by a curve, built by the Midland, which, however, has been used only for exchange purposes. Now that both companies are part of the London, Midland and Scottish, the curve can be used as an alternative route for goods and mineral trains from and to the Midland system. Before, however, that could be done with advantage, it was necessary to strengthen the bridges on the Buxton branch, and that, as related in our Seven-Day Journal on August 26th, has now been done. The contractors were Dorman, Long and Co., Ltd. Part of the work has also been the provision of an up and a down loop line at Dove Holes, also at Hazel Grove, on the Stockport line. These improvements have allowed for a new service of freight trains between Rowsley and Stockport, which not only duplicates the line between Millers Dale and Stockport, but gives direct access to the places in Lancashire and Cheshire served from the latter place by the former L. and N.W. system. The heavy gradients of the Midland route to Manchester commence at Rowsley, where there is a large marshalling yard.

Notes and Memoranda.

INVESTIGATION of the Monel metal roof of the Pennsylvania Railroad station in New York, which was laid in 1909, indicate that it will have a life of at least 300 years.

IT is said that the binary fluid power plant of the Kearny station of the Public Service Corporation, of New Jersey, which has a capacity of 20,000 kW, involves the use of 270,000 lb. of mercury in the primary boiler.

ACCORDING to statistics of the Ministry of Transport, although the number of horse-drawn vehicles has declined by 33 per cent. during the past three years, the tonnage horse-drawn has been reduced by only 13 per cent. It is estimated that there are eighty million horses at work in the world, apart from many which cannot be counted in Asia.

A CORRESPONDENT of the *Machinist*, giving a "tip" for the extraction of a broken stud, explains how the artizan or, shall we say, artist built up on to the exposed end of the stud a mass of metal by means of the oxy-acetylene blowpipe, and then succeeded in extracting the stud without marring the surrounding material. Had he got in mind the loosening effect of a red-hot poker applied to the head of a stubborn wood screw ?

A MANUFACTURER of light reflectors has been able to get a smoother surface and higher polish by experimenting with his pickling solutions, says the *Iron Age*. Previously he used sulphuric acid, followed by quick immersion in nitric acid. Now he uses muriatic acid in place of the sulphuric acid, with the nitric acid immersion as before, but with a shorter time in both baths. These are followed by the usual warm water rinse.

WITH a base of refined mineral oil free from acid, a percentage not exceeding about 18 per cent. of lubricating graphite, and a thickening of calcium oleat to stiffen, a lubricant for the interior of winding ropes of suitable consistency and melting point can be made. This lubricant, if carefully prepared and mixed, will maintain its characteristics throughout a long working life, and will not dry up, evaporate, or disappear in the course of years.

ACCORDING to a communication by Bernard Thomas in a recent issue of *Heat Treating and Forging*, where steel forgings have been annealed prior to hardening, scale often forms in hard patches on the surface. Such patches often will give rise to quench cracks. The more drastic the quenching medium the greater the possibility of their occurrence. Solid fuel-fired furnaces provide an atmosphere which produces an easily detachable scale, and occurrence of cracks is least likely in steel heated in such furnaces.

WRITING of Russia and her airships in *Flight*, Mr. H. Addinell states that at Zagi, the U.K. 1, named the "First of May," of 77,572 cubic feet capacity, with two motors totalling 150 H.P., a top speed of 52½ m.p.h., and a cruising speed of 50 m.p.h., and carrying a crew of seven, has been built, and the U.K. 2, of 176,300 cubic feet and 450 H.P., practically completed. In Leningrad there is nearing completion U.K. 3, of 229,190 cubic feet and 600 H.P., as well as U.K. 4, of 246,820 cubic feet.

IN an address before the Royal Scottish Society of Arts, Major Andrew McDowall discussed the practicability of land tillage by means of electric power. Dealing with the economic aspect of electrical tilling, he pointed out that the more universal the use of electricity the cheaper the method would become. His own tillage price, for example, was 1d. per unit, but universal electrical tillage would reduce the price considerably below that. Taking ¼d. as a fair price, the cost per acre by electric tractor would be 6s. 4½d., the corresponding cost with an oil tractor being 9s. 0½d. With improved design he estimated the costs could be reduced to 5s. 11d., a saving of practically 33 per cent. compared with an oil tractor.

AT a meeting of the South Wales Institute of Engineers, held recently at Cardiff, Mr. H. D. L. Lloyd read a paper on "Colliery Winding Ropes," in the course of which he pointed out that the most suitable composition for a steel wire rope was (per cent.) carbon, 0·4 to 0·7; manganese, 0·45 to 0·65; silicon, 0·05 to 0·15; sulphur, 0·04 max.; phosphorus, 0·04 max. The chief qualities required in a winding rope, in addition to high tensile strength, were flexibility and ability to resist wear, and in the wire, high fatigue value or toughness. The wire must have a sorbitic structure and no other. The author then went on to discuss the microstructure of rope wire and illustrated several typical examples, particularly cases where, in practice, good and bad results were obtained.

HERE is a rather novel idea of thought from the editor of the *Engineering News-Record*, in the introduction to an article by Mr. C. M. Stanley on "Dam Construction":—"With the construction of three steel dams in this country more than twenty yeras ago the use of metal as a dam material has been allowed to lapse. During this interval great strides have been taken by the steel industry, particularly in welding and in alloy discoveries. In consequence every old, partially developed method and material is or should be re-studied to determine its present status. Steel is essentially a new material so far as dams are concerned. Enormous sheets may be fabricated through welding. With expansion and contraction properly cared for there is no limit to the area to be so joined."

THE tensioning of strip steel in the process of cold reduction is made possible, says *Steel*, by a new type apparatus recently developed by W. C. McBain and patented by the Cold Metal Process Company, Youngstown, O. The device is adaptable to single-stand reversing strip mills and is of special importance in the large sizes of mills used for cold rolling strip for tin-plate or automobile body sheets where the cost of power is an important item. The patent claims the recovery of power from tensioning the strip as it is fed into the mill, thus making practical the use of higher back tensions in cold rolling. One 38in. Steckel cold strip mill with power recovery from the unwinding reel has been in operation at the plant of the Weirton Steel Company, Weirton, W. Va., for about two years. Benefits derived from back tensioning include flatter strip, easier guiding through the mill, and a saving in the quantity of cooling water.

Miscellanea.

A FISH-CANNING factory is to be put up at Dundee.

DURING 1931 some 156 million coins were struck in the Royal Mint.

A CEMENT factory is to be put up some six miles outside Coimbatore, Madras.

IT is claimed that the Italian cruiser "Bolzano" (10,000 tons) reached a speed of 38 knots during her guarantee trials in the Tyrrhenian Sea.

THE Hamble, Southampton, aeroplane works of A. V. Roe and Co., Ltd., are to be transferred to the company's main factory at Newton Heath, Manchester.

THE demand for exhibition space at the next British Industries Fair at Birmingham has been so great that in some cases two firms are sharing one stand.

A PLAN to connect the Baltic with the White Sea, which will involve the use of the rivers Dneiper, Volga, Dunai, Karna and Neva, is being considered by Russian engineers.

IT is officially estimated that factories started in this country by foreign concerns since November, 1931, will give employment to some 14,000 hands when they are fully occupied.

AFTER being closed down for nearly three years, the Cwmfelin Steel Works, Swansea, is to reopen immediately after the Christmas holidays, and some 300 men will find employment.

NINE firms, of which six are British, two French and one Italian, have tendered for the work of a storage scheme for irrigation on the Euphrates. It is proposed to use the Habbaniya depression to store flood waters and the scheme is estimated to cost about £1,250,000.

STOCKHOLM'S first underground railway, connecting some of the southern suburbs with the centre of the city, is now under construction. The last partition wall in the tunnel was demolished on December 1st, and it is expected that the railway will be completed by the beginning of next October.

THERE were fifty-nine furnaces in blast in the United Kingdom at the end of November, the same as at the beginning of the month, five furnaces having begun operations and five having been blown out. Production of pig iron in November amounted to 267,700 tons, compared with 275,600 tons in October, and 296,400 tons in November, 1931.

IN 1931 the output and value of nearly all mineral products in the U.S.A. continued the declines, already general at the end of 1930, at an accelerated pace. On account of the falling demand and lower unit prices, the aggregate value of all mineral products in 1931, 3,180,000,000 dollars, was the lowest since 1915. As compared with the total for the preceding year, the 1931 value represented a reduction of 33 per cent.

THE National Broadcasting Company of America is building a new television studio on the eighty-fifth floor of the Empire State Building at a height of 1000ft. above the street. The short-wave transmitting aerial is on the top of the airship mooring mast, and is 1250ft. above the street. The received images will be 6in. square and will be seen directly on the end of a cathode ray tube. Transmissions will be made from the Empire State studio on wave lengths of 5–7·5 m.

THE proposal of the Burrard Inlet Tunnel and Bridge Company to erect a 900,000 dollar vertical lift section in the Second Narrows Bridge at Vancouver, B.C., has been placed before a special commission of engineers for a report. The proposal is the alternative to a plan to put the old bascule span in working condition at an estimated cost of 250,000 dollars. The new plan is favoured, as it will provide a space 300ft. wide for navigation as against 120ft. in the old bascule lift.

THE 1931 production of engines, turbines, tractors, water wheels and windmills in the U.S.A. was valued at 148,092,982 dollars, a decrease of 63·5 per cent. as compared with 405,811,835 dollars reported to the Bureau of the Census for 1929. The items which make up the 1931 total are as follows:—Internal combustion engines, except tractors, 66,406,819 dollars; tractors, 58,658,818 dollars; steam turbines, 12,735,656 dollars; water wheels and water turbines, 6,889,351 dollars; reciprocating steam engines, 2,117,826 dollars; windmills, 1,284,812 dollars.

IT is reported by the National Federation of Iron and Steel Manufacturers that there were fifty-nine furnaces in blast at the end of November, the same as at the beginning of the month; five furnaces having commenced operations and five having been blown out. Production of pig iron in November amounted to 267,700 tons, compared with 275,600 tons in October and 296,400 tons in November, 1931. There was a slight increase in the daily rate compared with October. The production includes 63,000 tons of hematite, 128,300 tons of basic, 66,000 tons of foundry, and 7200 tons of forge pig iron. The output of steel ingots and castings amounted to 473,800 tons, compared with 439,800 tons in October and 459,200 tons in November, 1931.

AS a result of experiments conducted in the Yorkshire coalfields, there is a possibility that wireless will shortly become compulsory in the mines, as it has long been on passenger ships at sea. It has been discovered that, by means of a transmitter and large aerial at the pithead, messages can be sent to the workings and heard clearly at an underground distance of over two miles. The value of such a demonstration is hard to overestimate. It makes it possible to give immediate warning to men in distant workings of any danger from gas or fire, so that they can at once proceed to the shaft. Even minutes saved in this way may mean the preservation of hundreds of lives. Further experiments are now in progress to discover to what extent, by means of wireless-operated light signals, it is possible for danger warnings to be transmitted from the mine to the pithead, for broadcasting to other parts of the mine. When the scheme is perfect, instant information of fire or other danger, in however remote a working it occurs, will be available to every man whose safety may be threatened.

LAUSANNE WATER SUPPLY—INLET PIPE LINE IN THE LAKE OF GENEVA

(*For description see page 632*)

FIG. 5—LAUNCHING THE PIPE INTO THE STOCKALPER CANAL

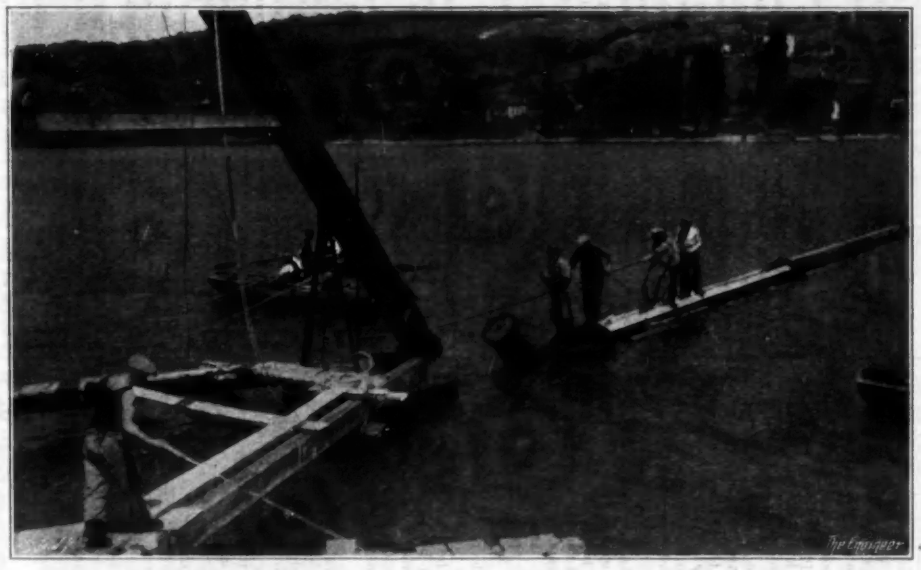


FIG. 6—BRINGING THE PIPE LINE AND THE INTAKE PIPE TOGETHER

FIG. 7—JOINING UP THE INTAKE PIPE

FIG. 8—TOP OF THE INTAKE PIPE

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CULTURE AND TECHNOLOGY.

WE find, both at home and abroad, a growing conviction that the inducements to young men to follow an engineering career have been carried too far. The annual world-output of scientific graduates from universities reaches a very large figure, and it is far exceeded by the output from colleges of less than university rank and from municipal schools and night classes. When only one or two countries were supplying others with trained and educated men, there were sound reasons for urging young men to take up the engineering profession; but now that all the leading industrial nations have their own technical colleges in superabundance, the supply is becoming greater than the demand. We believe that at the present moment only Russia is ready to absorb a material number of foreign-trained engineers, but the terms she offers can scarcely be described as attractive. India, of course, draws a number of young men from this country, and the Dominions take some, but the demand for Englishmen is less than it was, and, apart from an almost inconsiderable quantity, the men trained in our schools and colleges have to seek employment in their native land. We are aware that employers have stated that industry can absorb all the technically educated men the schools produce. We believe, however, that on close examination it will be found that what managers are seeking for is more intelligent artisans and mechanics, and that whilst they are glad to have the assistance of college graduates for their research and scientific work, they are not in a position to offer permanent occupation to all the men that are turned out. It is in that respect that the reports of universities and colleges may be misleading. They do not go far enough. In normal times—not at present—the professors are able to find places for nearly all their graduates, but if they could follow the careers of those graduates they would find that, after a few years of pupilage in works at small pay, the search for work at a salary commensurate with the cost of education was so hopeless that a proportion of these scientifically educated and trained men drifted into other occupations.

We do not say that that is a bad thing. On the contrary, we are disposed to think that technical, and, particularly, scientific, education may form an admirable foundation for vocations which seem, on the face, to have nothing whatever to do with science or technology. But there is always the danger, especially in the smaller technical schools and colleges, that the education will be so narrow, so specialised, so essentially vocational, that the student will be not only quite unfitted for any other occupation than that which he has been taught, but, owing to his restricted outlook, may be far from the best even in it. From such seeds discontentment grows. The narrow man complains because he cannot find work within the very small ambit of his capacities, and grumbles against the broader man who, with less specialised qualities, finds occupation and success. Hence, whilst we are ready to agree that a scientific education may be good for any subsequent career, we add the proviso that it must be conceived on lines which will broaden rather than constrict the intellect and, in consequence, will encourage excursions into subjects which are outside the usual definitions of science. To our way of thinking, it is impossible to lay the basis of an engineering education too wide. But if breadth is desirable when the education is vocational it is essential when the object is to prepare the student for whatever may "turn up." It may be said that no one would think of pursuing science and technology if it were not his intention to practise them. It may be so now, but just as the modern side has been adopted for the general education given in public schools we may see the day when a large percentage of those who go to our scientific universities will do so in search of a liberal education, and with no defined ulterior motives. However that may be, and whether we look upon a scientific education as either vocational or liberal, we reach the same conclusion that breadth is essential. And when we say breadth, we mean not only scientific and technical breadth. On former occasions we have called attention to the views of American educationalists and employers on this matter. They have recognised more completely, perhaps, than European engineers in general that since science and engineering are intruding more and more into everyday life, the obligations of the engineer towards his fellowmen are daily increasing. He cannot stand apart from the ordinary affairs of the world. In fact, he is called upon to take a leading part in them, and unless he is a man of wide sympathies he cannot do so effectively. That is one aspect. Another is that experience has shown the broad man to be the better in his vocation. It is, perhaps, worth quoting a few sentences from an authoritative American statement on the subject. They are taken from a pamphlet just published by the Engineering Foundation of New York—a body which is supported by many American engineering institutions. This pamphlet is entitled "Engineering—A Career, A Culture," and is called "A Message to Young Men, to Parents, and Teachers." "More," it says, "is required of an engineer than knowledge of science and technology. He must be greater than the things he designs and uses. . . . Before he is an engineer, he is a human being, living in a community of other human beings, and of this fact he must never lose sight. . . . Many skilful specialists fail to serve mightily because, like a highly developed tool, they are adapted to a single purpose only. . . . The engineer should have a sympathetic appreciation of the world in which he lives. His education should enlarge his understanding of that world, through study of its cultures, past and present, and of economics. philosophy, psychology, and sociology. . . . While engineering courses offer serious difficulties to students unfitted for them, the well-prepared student whose career properly lies in engineering will not only master his studies, but find opportunities for extra-curricular activities as well. These should be primarily directed towards developing a man's human side."

There's room for all sorts in this world of ours, even for the narrow specialist, and we have no desire to do less than the greatest honour to the men who have shut themselves from the ordinary affairs and by concentration have achieved mastery over a single subject. Such men will find themselves; we need not seek them. It is with the humdrum men who must carry on the business of ordinary living that we are concerned. Our system of education and training is designed for them, not for the genius. We have to think of it as it will affect them. It is because experience shows daily that the man of broad sympathies and liberal education, even though he be an engineer, does better and finds greater opportunities than the narrow man that opinion in America is so strongly in favour of what one might term a cultural element even in technical education. It is difficult, we know, to fit it into the curricula of colleges, but even in them a little might be done if it were once appreciated by authorities that the subjects of examinations are not always those that will be most profitable to the student in his after-college career.

Articulated Locomotives.

THE continual increase in train loading, consequent upon the demands made for more economical working, together with the development that has taken place in the traffic on lines in more or less undeveloped countries, are the factors which have been instrumental in bringing the articulated type of steam locomotive into the prominent position it occupies at the present day. Articulation, or the division of the driving mechanism into two, and, in certain cases, three separate driving units, together with relatively light individual axle loading for a given tractive effort, are the features which characterise the articulated locomotive, and it is the extent of the desirability of these features which decides for or against its use when the motive power for a given service is in question. When lines abounding in sharp curves, and at the same time heavy gradients, are to be worked, some form of locomotive having a flexible wheel base is essential, and it is on such roads that the articulated design has been mostly used. There are, however, other circumstances which have also led to the employment of the articulated engine. We refer to cases where high power is required from inferior fuels, necessitating boilers of more than ordinary proportions to provide the necessary steam, and involving the use of large fire-boxes and grate areas.

The three most highly developed types of articulated locomotives are the "Mallet," the "Garratt," and the "Meyer," and a reference to the articles which recently appeared in our pages, will show that the first-named has been built to huge dimensions for service on the railways of the United States. The "Garratt" engine differs in many respects from the "Mallet," for whereas in the latter both the power units are arranged under the boiler, in the case of the former they are entirely separate, and arranged to swing from pivot centres at each end of the frame supporting the boiler. Actually, the "Mallet" has only one articulated section, which is the leading power bogie, while the "Garratt" is wholly articulated, both the power units being separate from the boiler section. The "Mallet" was, in the first instance, built as a four-cylinder compound, Monsieur Mallet being a firm supporter of the compound principle, and for many years, through the early development of this type, compound cylinders were characteristic of the design. In construction, the "Mallet" is suitable for compounding, as the hind driving unit is rigid with the boiler; thus the high-pressure cylinders can be mounted on this section, and the high-pressure steam connections made to the cylinders without the intervention of flexible joints, which are required only for the receiver and exhaust piping for the low-pressure engine mounted on the leading power unit. The "Garratt," and, in fact, any of the other well-known articulated locomotives, are not so well adapted for compounding, as not only must all the pipe connections perforce be fitted with flexible joints, but the cylinders in each unit are much further apart, making the low-pressure connecting pipes of considerable length. Compared with the "Mallet," the "Garratt" seems to have what may become a great advantage, for, owing to the system of articulation, the coupled wheels may be of any required diameter, thus the design can, in this respect, be made suitable for high-speed service, as shown by recent trials in France. This is not the case with the "Mallet," for even with such a liberal load gauge as exists in the United States, nothing larger than a 73in. wheel has so far been attempted. But the small size of the driving wheels limits the speeds that can be economically attained, and has led to another solution of the problem of securing high running speed with tractive effort at low velocities. A case of this kind is seen on the Chesapeake and Ohio Railroad, where a successful simple expansion "Mallet" has given place to a new design of 2–10–4 locomotive, which, although having 69in., as against 57in. driving wheels, can exert the same pull at speed as the "Mallet," and by reason of a booster applied to the trailing four-wheeled truck, also exert an equal starting effort, and develop high tractive effort when needed.

Articulated locomotives must be more compli-

cated in construction than those of the usual type, and more costly to build, and possibly to maintain. On the other hand, they are, in reality, two engines, with but one boiler, and are therefore an acceptable alternative for the normal type when the extra cylinder power and adhesive weight can be fully utilised. Hitherto they have not been seriously considered for high speeds, despite a few examples which showed their capabilities in that direction, but it is not impossible that the "Garratt" type, which, as we have already seen, can be fitted with large driving wheels, may make progress for heavy express passenger and goods trains.

Institution of Mechanical Engineers

Two papers on cognate subjects and by the same author were presented before the Institution of Mechanical Engineers last Friday evening. Almost inevitably the discussion which ensued centred round the shorter, the more easily followed, and, as it happened, the less important of the papers. Dr. G. F. Mucklow was the author. His first, the shorter, paper gave the results of experiments carried out in the Engineering Laboratory of Manchester University on the temperatures reached during various conditions of working by the piston of a 66 B.H.P. Crossley solid-injection heavy-oil engine. His second paper presented a study of the effects of supercharging at various compression ratios in two different designs of cylinder, namely, the two-valve all-steel cylinder of a Napier aero-engine and the four-valve composite cylinder of a Rolls-Royce aero-engine.

Piston Temperatures.

The piston of the engine with which the experiments detailed in the first paper were carried out is illustrated in Fig. 1. It is characterised by the presence of a large knob at the centre of the crown and of a steel plate diaphragm entirely closing in the cavity under the crown. The temperatures acquired by the piston when the engine was running were measured by means of thermocouples attached at the fourteen points indicated in the engraving. The results of the investigation are here summarised :—

(1) *Piston Temperatures under Normal Conditions.*—The highest temperatures were recorded in the centre of the knob in the crown, the temperature at this point ranging from 353 deg. Cent. at no load to 650 deg. Cent. at full load. The temperatures at other points in the knob are also high, the temperature at the root of the knob being approximately 550 deg. Cent. under full-load conditions. The temperature at points on the edge of the crown is very considerably below that of the central knob, and varies from approximately 130 deg. Cent. at no load to approximately 230 deg. Cent. at 66 B.H.P. The temperature at points between the two sets of rings shows little variation with changes of load on the engine, and is at all times very low, the highest temperature recorded at this point under full-load conditions being 54 deg. Cent. At points in the skirt below the second set of rings the temperature was below 40 deg. Cent. under all conditions of load, the temperatures on the lower side of the skirt being slightly below those at corresponding points on the upper side. The cooling water to the jacket is admitted cold at the underside of the cylinder.

(2) *Heat Flow from Piston.*—Since the circulation of air beneath the piston crown is prevented by the diaphragm plate, the bulk of the heat given to the piston must pass down to the walls. In view of the very low temperatures recorded below the first set of rings and in the skirt, there can be little doubt that the main part of the heat received by the piston is passed to the jacket water *vid* the piston ring belt.

(3) *Piston Temperatures after Sudden Changes of Load.*—Two sets of observations were made of the rate of temperature rise at the various points in the piston during the period immediately following a change of load. The greatest rate of temperature rise was observed when the engine was started from the cold condition under a load corresponding to 24 B.H.P. For the first five minutes or so the temperature at points in the knob rose at a rate of approximately 33 deg. Cent. per minute. If full load is suddenly applied to the engine when running light, the temperature at points in the skirt reaches a steady temperature within twenty minutes or so. The knob continued to rise in temperature for upwards of fifty minutes after the change.

(4) *Effect of Variations in Jacket Water Temperature.*—A series of trials was run at a constant load, corresponding to 38·1 B.H.P., with different jacket water temperatures, the temperature at outlet to the cylinder jacket being varied from 22 deg. to 85 deg. Cent. It was found that there was an appreciable reduction in the specific fuel consumption with increase in the jacket water temperature. Thus, at 38·1 B.H.P., the consumption fell from approximately 0·469 lb. to 0·430 lb. per B.H.P.-hour for an increase in jacket outlet temperature of from 25 deg. to 85 deg. Cent., this effect being attributable to a reduction in piston friction consequent on the decrease in viscosity of the oil film. It is estimated that, by raising the jacket outlet temperature from 25 deg. to 85 deg. Cent., the energy spent in piston friction is reduced by approximately 2·8 H.P. Since the bulk of the energy spent in piston friction is returned as heat to the piston friction surfaces, a reduction in piston friction will, apart from other considerations, result in a cooler piston. With the jacket outlet temperature raised from 25 deg. to 85 deg. Cent., the temperature at points in the piston knob is reduced by approximately 35 deg. Cent. It is considered that approximately one-half of this fall in temperature is to be attributed to the reduction in fuel consumption, the other half being caused by a general fall in temperature of the piston due to the reduction in frictional heating. For the same increase in the water temperature at exit from the jacket, the temperature at points close to the edge of the crown remains practically unchanged, the average temperature at points in the skirt increasing by approximately 11 deg. Cent. On the assumption that an increase of 60 deg. Cent. in the outlet temperature of the jacket water corresponds to an increase of 30 deg. Cent. in the mean temperature of the water in contact with the liner, it might be expected that the temperature of the piston skirt would increase by some 30 deg. Cent. Since the observed increase in temperature is approximately 11 deg. Cent., it appears that the reduction in piston friction at the higher jacket temperature is sufficient to account for a reduction of approximately 19 deg. Cent. in the temperature of the piston as a whole.

(5) *Effect of Allowing Air to Circulate under the Piston Crown.*—On removal of the diaphragm plate a slight decrease in piston temperature occurred, the cooling effect increasing with increase of load. For points in the knob the decrease in temperature ranged from approximately 4 deg. Cent. at 25 B.H.P. to approximately 17 deg. Cent. at 65 B.H.P. The temperatures at points in the skirt were only very slightly affected by removal of the diaphragm plate, the decrease in temperature under full-load conditions being only some 4 deg. Cent. Removal of the diaphragm plate produced no perceptible change in the specific fuel consumption.

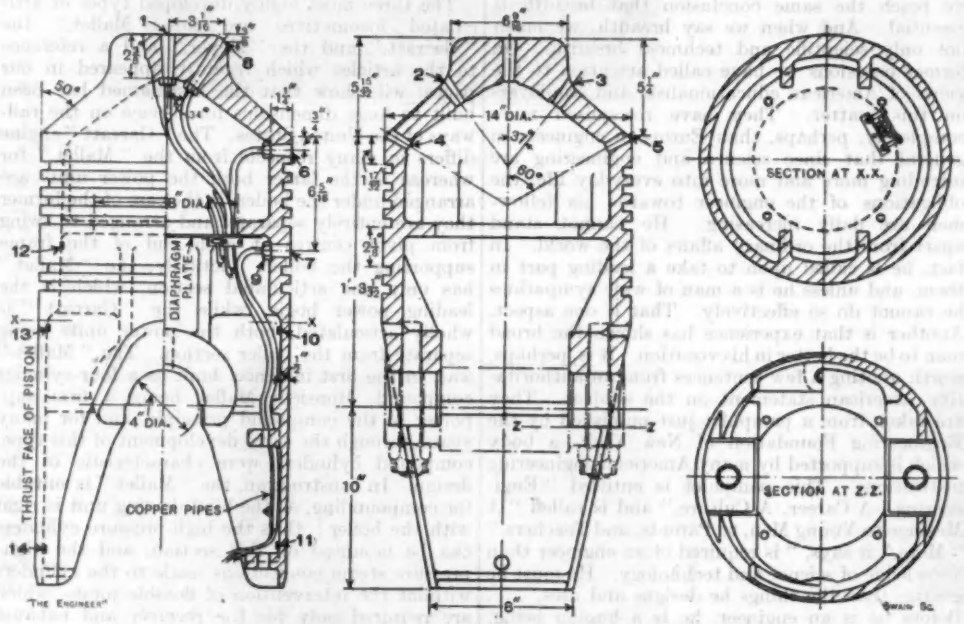


FIG. 1—PISTON OF 66 B.H.P. EXPERIMENTAL OIL ENGINE

Supercharged Petrol Engines.

The work described in the second paper was designed to determine the effects of increased induction pressure, at a range of compression ratios, on the power output, heat losses, fuel consumption, &c., of the Napier and Rolls-Royce aero-engine cylinders. The tests were all carried out at a speed of 1600 r.p.m. Straight petrol was used as the fuel for the Napier cylinder, and pure benzole for the Rolls-Royce. The compression ratios were 3·5, 4·0 and 4·5 to 1 with petrol, and 4·0, 5·0, 5·5, 6·5 and 7·0 to 1 with benzole as the fuel. The compression ratio was varied by inserting packing plates between the cylinder and the crank case. In all the tests the compressed air for the supercharging was obtained from a separately driven Reavell compressor which supplied air to the cylinder under test through an intercooler. The performance of the engine cylinder when driving its own supercharger was deduced by adjusting the experimental results for the power calculated to be required to compress the air at 65 per cent. adiabatic efficiency from the mean temperature and pressure at the inlet to the blower to the mean pressure at induction. At each compression ratio trials were run at a number of supercharge pressures. At each supercharge pressure the engine cylinder was run with the mixture strength weakened as far as possible consistent with steady running. Observations were then made of the induction pressure, the power output, the fuel, and air consumption, the heat flow to the cylinder jackets and to the exhaust, and the maximum pressure developed on ignition. The mixture strength was then slightly enriched and the observations were repeated. This procedure was continued until a mixture strength was reached at which the power had noticeably passed its maximum value. The induction pressure was then increased by a predetermined amount and a similar series of tests made at different mixture strengths. The process was continued until severe detonation or the onset of pre-ignition made farther progress unwise. The results are presented in the paper in the form of "mixture loop" curves—that is to say, the fuel consumption, heat to exhaust, and the other quantities measured at any one compression ratio and at the various induction pressures are shown plotted as a family of curves on a basis of air-fuel ratio, each member of the family in any one diagram representing a particular induction pressure. For the further use made of the results presented in this manner and for the conclusions deduced from them, the reader should consult the original paper. One of the most important deductions appears to be the fact that at a given compression ratio the ratio of the indicated horse-power to the weight of the charge per minute is constant and independent of the induction pressure, provided the ignition is not seriously retarded. The value of this ratio is, moreover, the same for both the Napier and the Rolls-Royce cylinders at the same compression ratio and remains unchanged whether the fuel is petrol or benzole.

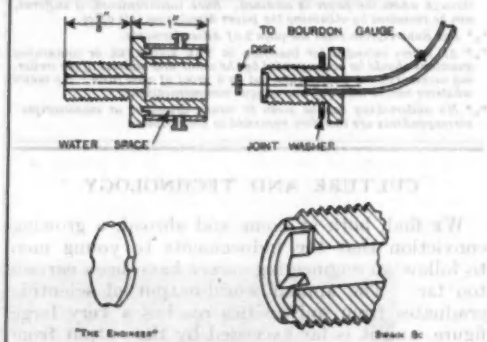


FIG. 2—MAXIMUM PRESSURE INDICATOR

For measuring the maximum pressure developed in the Napier cylinder an Okill indicator was employed, but for the same purpose in the case of the Rolls-Royce cylinder the use of that form of indicator was precluded and the special type of indicator illustrated in Fig. 2 was designed and constructed. This device consists of a non-return valve in the form of a light steel disc, $\frac{1}{8}$in. in diameter and 0·043in. thick, which moves between two annular seatings in the body of the instrument. The body is water-cooled and screws into the gas starter plug hole in the cylinder. The disc has a travel of 0·016in. between its seatings. On the cylinder side the seating is plane, while on the side remote from the cylinder the seating is formed with radial grooves. The disc allows gas to pass out from the cylinder into a pipe connected to a Bourdon gauge, but prevents any return flow to the cylinder. The pressure in the pipe therefore rises at each explosion until it attains a value equal to the maximum cylinder pressure. A needle valve at the gauge allows the pressure to be reduced when it is desired to take a fresh reading. A peculiar feature was observed

when this needle valve was used at high supercharge. When it was opened a fluid was ejected from it, and on analysis this fluid was found to consist chiefly of nitric acid with traces of sulphuric acid and nitrobenzene.

THE DISCUSSION.

Mr. Charles Day opened the discussion and, like nearly all the subsequent speakers, dealt solely with the paper on piston temperatures. His remarks were chiefly directed towards a comparison of Dr. Mucklow's figures for a piston having a central knob with similar figures which he, Mr. Day, had found for a piston with a concave crown without a knob. He presented the comparison in the form of the following table, in which columns A and B relate to Mr. Day's engine with its concave piston, and column C to Dr. Mucklow's engine as tested with the diaphragm removed, the most favourable condition as regarded the temperatures of the piston:

Load.	A. Full.	B. Full.	C. Full.
I.M.E.P.	100 ..	100 ..	95
Temperature of cooling water at outlet, deg. Cent.	43 ..	71 ..	27
Temperature at centre of piston crown	438 ..	449 ..	645
Temperature at intermediate position on piston crown ..	404 ..	421 ..	545
Temperature at edge of crown ..	316 ..	332 ..	230
Difference between temperatures at centre and edge	122 ..	117 ..	415

These figures brought out very clearly the high concentration of temperature at the centre of the piston produced by the presence of the knob. The engine on which his tests had been carried out was very similar in size to Dr. Mucklow's. Although for the purpose of his comparison he had selected Dr. Mucklow's figures for the piston with the diaphragm removed, it would not, he said, be advisable to run the engine without the diaphragm, which was intended to prevent the lubricating oil from reaching the very hot interior of the piston, where it would probably char and from which the charred particles might fall down into the engine bearings.

Mr. A. E. L. Chorlton remarked that the knob of the piston in Dr. Mucklow's engine entered the combustion space at the inner end of the stroke and was the only portion of the piston exposed to the ignition temperature at the outset of the working stroke. As soon as the piston began to move there was a very great flow of heat past the crown of the piston outwardly from the centre. Dr. Mucklow's engine had a very low compression ratio and in general was not representative of modern practice. Dealing briefly with the second paper, Mr. Chorlton called attention to the fact that the overlap between the opening of the inlet valve and the closing of the exhaust valve in the setting adopted by the author for his experiments was 30 deg., as compared with 100 deg. or even 120 deg. in some designs of supercharged engines. Had the author, he asked, made any experiments to determine whether there was any direct loss of charge through the open exhaust valve during the scavenging period? The paper raised the important question whether it were better to compress all the air required for the charge or only the extra air for the supercharge. It had been asserted that a saving of 40 per cent. in power could be realised by compressing all the air.

Mr. W. A. Tookey desired to know how much of the cooling water in the author's Crossley engine did actually go through the cylinder jacket. The water inlet was directly below the water outlet, and he suggested that in those conditions the water at the end of the jacket remote from the breech end of the cylinder was largely stagnant. If that were so it was understandable why a change in the circulating water temperature had little effect on the temperature of the skirt of the piston.

Professor Lomonosoff thought that the first paper was very interesting from the point of view of the design of "Diesel" locomotives, but felt that the results would have been more valuable if the engine experimented with had had a compression ratio of 18 to 1.

Mr. R. Stansfield, of the Engine Research Branch of the Anglo-Persian Oil Company, criticised the author's suggestion that when the outlet water temperature was raised from 25 deg. Cent. to 85 deg. Cent. the consequent reduction in piston friction was sufficient to account for a reduction of about 19 deg. in the temperature of the piston as a whole. He thought that the thermocouple temperatures would change with changes in the delay angle of the fuel used and with the consequent changes in the shock of combustion. There was some evidence from marine practice that the use of a long-delay fuel instead of a short-delay fuel might lead to the cracking of pistons by reason of the increased temperature range set up in the pistons. He contended that experiments such as those described by the author should be made with a variety of fuels, say, covering a range from a high-standard gas oil to creosote with intermediate fuels composed of varying mixtures of gas oil and creosote.

Wing Commander Cave-Brown-Cave expressed great admiration for the author's maximum pressure indicator and described it as a very valuable addition to the facilities for engine research. A maximum pressure indicator, he said, was the most satisfactory method of determining whether any cylinder of a multi-cylinder engine was failing to function correctly. Dealing with the first paper, he criticised the use of the jacket outlet temperature as an indication of the mean jacket temperature. In aero-engines jacket outlet temperatures of 100 deg. had been found quite satisfactory, and he suggested that the author should continue his experiments until the jacket outlet temperature had been raised to boiling point. The ability to run with the jacket outlet water at boiling point was now a general feature of the official tests for aero-engines.

Mr. E. J. Fearn discussed the merits of supercharging *versus* high compression ratio. It was, he said, generally agreed to-day that if a large increase of power were required it was necessary to use a supercharger. To realise a given indicated mean effective pressure it was necessary to use a much higher maximum pressure with a high compression engine than with a supercharged engine. In addition, the maximum temperature was much less in a supercharged engine than in a high compression engine.

Lt.-Col. Kitson Clark agreed with Wing Commander Cave-Brown-Cave that it was desirable to continue the experiments with a much higher cooling water temperature than that used by the author. In the Kitson-Still engine the jackets were directly connected with the steam generator and worked with temperatures up to 190 deg. Fah. So far they had not had a single case of a cracked piston.

Dr. Mucklow, replying to the discussion, said that the experiments described in the first paper were undertaken to determine the temperatures of the piston and not the effect of the jacket temperature on the fuel consumption. He quite agreed that the mean jacket temperature was probably not the same as the outlet temperature, and that the water at the breech end was probably much hotter than that at the other end. Dealing with Mr. Chorlton's remarks, he said that with an overlap of 30 deg. in the valve setting very little air escaped through the exhaust valve, but with overlaps greater than 30 deg. the amount of air which escaped had been found to increase very rapidly. The maximum pressure indicator had given a little trouble as a result of the hammering of the disc on its seatings, but if the disc had been properly made of hardened steel the device, he thought, would have been quite satisfactory.

Literature.

Ten Years of Industrial Psychology. By HENRY J. WELCH and CHARLES S. MYERS. London: Sir Isaac Pitman and Sons, Ltd. 1932. Pages 146. Price 6s. net.

IT is highly probable that many readers of this paper are unaware of the existence of the National Institute of Industrial Psychology, although it has been in existence for upwards of a decade. It is its development that provides the main theme of "Ten Years of Industrial Psychology," which also furnishes a record of some of the investigations that have been conducted. The Institute's principles have been not to press the worker from behind, but rather to reduce or remove all causes of friction, &c., from the front. It aims at eventually occupying in industry a position analogous to that held in physical science by the National Physical Laboratory, and apparently its foundations have been well and truly laid. Perhaps one of its greatest assets lies in the fact that it has not alienated the trade unions, but in many cases its work has been cordially approved by them.

Investigations in vocational selection—to mention one important activity—were begun by considering posts to be filled by the rank and file, but at the present time the selection of salesmen, managers, and candidates for posts of high responsibility can be undertaken with a reasonable hope of success.

As an indication of the growth of the Institute, it may be mentioned that in 1921 the amount received in fees for investigations which were conducted was about £1000, while in 1930 it was over £20,000, and in that period the membership roll had increased from about a hundred to 1600.

From its start it has made no profits, and has claimed that one of its primary objects has always been to seek to benefit the community, and, so far has it been able to justify this contention that it has not only been eligible for grants from the Carnegie Trust, but it has also been absolved from payments of income tax, rates, &c.

In this book will be found not only a historical sketch of the life of the Institute, but a lucid description of its manifold activities, embracing such subjects as vocational guidance and research, educational facilities, industrial and commercial investigations, work that has been undertaken for the Government and municipal bodies, and what it has attempted in a charitable way. Interesting details of its manner of approaching the problems that have been entrusted to it are given and the results obtained are clearly indicated.

A chapter is devoted to its general constitution, and in it appears a list of its officials and staff. We notice that a number have left the Institute's service after a few years, but invariably to take up some responsible position in the industrial or educational world.

At the end of an interesting book the authors assume the *rôle* of prophet, and look into the future with confidence. So far their main concern has been the promotion of production, but they look forward to investigations with a view to improving the distributive side of industry, and they even anticipate trade unions invoking the aid of the industrial psychologist. They expect the larger and more prosperous concerns to establish departments of industrial psychology, and envisage a future when "every large factory, store, and office, and every university, will have an industrial psychologist immediately or indirectly attached to it." With all the developments of the last ten years before us, it would be rash to question the conclusions drawn. Let us hope that the old and much-abused term "welfare work" will sink into oblivion, but that the useful labours prosecuted under the title will continue in a more systematic and acceptable manner under the ægis of the industrial psychologist.

BOOKS RECEIVED.

Examples in the Theory of Structures. By J. W. Landon, M.A. London: Cambridge University Press, Fetter-lane, E.C.1. Price 5s. net.

Die Luftspeicher-Dieselmaschine. By Dr.-Ing. Berthold Klafton. Berlin: Carl Heymanns, Mauerstrasse 44, W.8. Price 16 marks.

Eigenspannungen in groben Schmiedestücken. By Dr.-Ing. G. Kirchberg. Berlin: V.D.I.-Verlag G.m.b.H., Dorotheenstrasse, N.W.7. Price 5 marks.

The National Physical Laboratory: Collected Researches. Vol. 23. 1932. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price £1 net.

Garcke's Manual of Electrical Undertakings and Directory of Officials. Vol. 35. 1932. London: Electrical Press, Ltd., 13–16, Fisher-street, W.C.1. Price 35s. net.

Zuschlagermittlung in der Massenfabrikation für freie und gebundene Handarbeit. By Dr.-Ing. R. Engel. Berlin: V.D.I.-Verlag G.m.b.H., Dorotheenstrasse, N.W.7. Price 4·10 marks.

Pumping Machinery. Part I.: Historical Notes on the Collection in the Science Museum. By G. F. Westcott, B.A. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 2s. 6d. net.

Investigation of Warm Air Furnaces and Heating Systems. Part V. By A. C. Willard, A. P. Kratz, and S. Konzo. Urbana: Engineering Experiment Station, University of Illinois, U.S.A. Price 80 cents.

Lewis's Railway Signal Engineering (Mechanical). Third edition, revised and enlarged. By J. H. Fraser, B.Sc. London: Constable and Co., Ltd., 10, Orange-street, W.C.2. Price 16s. net.

The "Practical Engineer" Electrical Pocket Book and Diary, 1933. Edited by Conrad Arnold, A.M.I.E.E. London: Oxford University Press, Amen House, Warwick-square, E.C.4. Price 2s. 6d. net.

The "Practical Engineer" Mechanical Pocket Book and Diary, 1933. Edited by E. G. Black, A.M. Inst. C.E., &c. London: Oxford University Press, Amen House, Warwick-square, E.C.4. Price 2s. 6d. net.

SIXTY YEARS AGO.

IN an oration on Macquorn Rankine, at Glasgow University, on June 15th this year—reprinted in our issue of June 24th—Sir James Henderson asserted that practically the only published records of the life of Rankine consisted of a two-column obituary notice in the *Glasgow Herald*, written by Professor Tait, of Edinburgh, and an article by Maxwell in *Nature*, published six years after his death. We accepted Sir James' statement as correct so far as this journal was concerned, for on turning to our issue of December 27th, 1872, we found that our obituary notice consisted of twenty-two lines. We had fully expected to have been able to refute Sir James' statement, for Rankine in his day was a very frequent and highly valued contributor to our columns. But these two-and-twenty lines confuted us and seemed clearly to establish our neglect. Nevertheless, Sir James did not search far enough, nor did we in our efforts to clear ourselves from the charge implied in his statement. We did do full justice to Rankine's greatness, but not in the issue in which the historical investigator of to-day would expect to find it. The truth is that Rankine's death occurred on a day which was extremely awkward from the journalistic point of view. He passed away at Glasgow just before midnight on Tuesday, December 24th, 1872. The news of his death could not possibly have reached us until some time on Christmas Day and almost certainly did not arrive until we were on the point of going to press on Boxing Day, Thursday, December 26th. It appears very probable that our brief notice was written in haste and dropped into the page at the last moment. Unfortunately, from the point of view of the modern investigator, our opening words—"Sad news is best told briefly"—seem to imply that it was not our intention to revert to the subject at a later date. Unfortunately, too, we did not conclude our brief notice with a statement to the effect that we definitely would so revert to it. Equally unfortunate from the same point of view is the fact that our issue of December 27th, 1872, was the last of the half-yearly volume. Most unfortunate of all, the index to our succeeding volume is faulty in so far that it fails to include an entry of the extended notice of Rankine's life and work which we published in our issue of January 3rd, 1873. We are glad to find, even although our discovery has been somewhat delayed, that we did do justice to Rankine at the time of his death and that we share with the *Glasgow Herald* the honour of having given immediate expression to our sense of his greatness. It may be added that our extended notice adds nothing to the facts concerning Rankine's early life presented in Sir James Henderson's elegant oration.

Basic Bessemer Practice in France.

IN connection with the commemoration ceremonies which took place in Paris recently, on the occasion of the fiftieth anniversary of the introduction of the basic process for the manufacture of steel in France, an account of which appeared in THE ENGINEER last week, both Monsieur Portevin and Monsieur Baclé made references to a new process destined greatly to improve metallurgical practice in the manufacture of steel by that process. We present below the *résumé* of an article which has just appeared in the current issue of the *Revue de Métallurgie*, descriptive of what its author calls "A New Process for the Dephosphorisation of Pig Iron in the Basic Converter." It is by the well-known French metallurgist, Monsieur F. Bicheroux, and gives an account of experiments made with the object of introducing certain improvements in the mode of carrying out the blow in basic Bessemer practice with the object of remedying some of the disadvantages said to attach to the usual method of conducting the process. It is believed that it is this process which was the subject of the remarks to which reference is made above.

The article by Monsieur Bicheroux deals exclusively with the metallurgical considerations underlying the new process, the essential feature of which is the introduction of finely divided lime into the air blast with the object of inducing an earlier elimination of the phosphorus of the charge than is possible in existing practice. In spite of the many practical difficulties which might be anticipated by the adoption of this device, the theory of the new process appears to be sound both from chemical and thermal considerations involved in the elimination of phosphorus during the course of basic Bessemer practice.

Monsieur Bicheroux claims, at the outset, that the new method will enable pig iron lower in phosphorus than is usual in current practice to be used in the basic Bessemer converter, and thus widen greatly the scope of the process which, he says, has remained practically without the introduction of any improvements since its invention. It still involves the juxtaposition of molten pig iron and lumps of cold lime in circumstances which fail to fulfil any of the conditions necessary to ensure satisfactory reactions, namely, the correct proportioning of the reagents involved in the reaction, their addition at the right time, their intimate admixture, and the uniformity of their temperature. Moreover, the tendency constantly to employ pig iron with lower and lower silicon percentages compels makers to keep the phosphorus content of the pig at an irreducible minimum of 1·7 per cent. As very few ore deposits now exist capable of yielding pig iron of this composition, the basic converter has, for the last thirty years, been steadily declining in importance, in favour of the open hearth, which is not subject to so narrow a limitation, and the pneumatic process, in spite of its rapidity and cheapness, appears to be marked out for steady decline unless it can be extended to the use of pig irons containing lower amounts of phosphorus.

Within the temperature range of metallurgical operations phosphorus has a lower affinity for oxygen than either silicon or manganese, but a higher affinity than carbon. It should therefore be possible to eliminate it during decarburisation (as in the comparatively low-temperature puddling furnace, as well as in the high-temperature open hearth) and, as a matter of fact, in the Bell-Krupp process, 80 per cent. of the phosphorus is eliminated before decarburisation even begins. If, therefore, in the basic converter the charge, when the flame drops, still contains 30 to 40 per cent. of its initial phosphorus content the conditions of the reaction must be defective. The reason for this is that the addition of a large quantity of cold lime, in lumps, necessitates a longer time to heat it up, reduce the lumps to fragments, dissolve them, and allow for the resulting reactions, than the time it takes for the bath to decarburise. The after-blow becomes necessary less for the purpose of oxidising the residual phosphorus than in order to complete the melting of the excess of solid lime, which remains inactive in the molten magma which constitutes the slag at the time, and most of the other reactions have been completed before this result has been attained.

Charging lime into the converter at the very commencement of the process—as is the practice in basic Bessemer working—not only retards the end reactions but affects them adversely from the start. Monsieur Bicheroux develops this theme at some length, adducing thermo-chemical evidence in support of his arguments, and concludes that, in order to improve the conditions in which a basic Bessemer charge is to be worked, it is necessary fundamentally to change the mode of using the lime. In order that it shall not exercise a disturbing influence it is necessary that it shall have no cooling effect on the bath, and that its action shall be confined solely to producing a fluid slag. Further, it must, during decarburisation, confer upon the initial slag the strongly basic properties which effect the neutralisation of the phosphoric acid, step by step with its formation.*

In the process as described by Monsieur Bicheroux the lime is therefore added in two stages. In the first a little is introduced into the converter before charging the metal, as in existing practice, or, alternatively, some of the slag from the preceding blow is rabbled back into the converter after pouring the molten metal off into the ladle. The lime (or slag) so added must suffice to yield a slag of low melting point with the silica and the manganese oxide formed during the desiliconising stage, without the help of oxidised iron. Owing to the turbulence of the bath this slag forms an intimate emulsion with the metal, which tends to keep the lime pulverulent during its passage and helps to absorb it contemporaneously with its introduction. The second addition should take place as soon as this emulsified condition has been attained, that is to say, when the gas emerging from the converter lights up.

The oxidation of the impurities of the charge, inclusive of the amount of iron burned towards the end of the blow, requires about 80 kilos. of oxygen per metric ton of pig iron, or 6000 kilos. (equivalent to 4800 cubic metres of air) in the case of a 15-ton converter. A blowing engine delivering 500 kilos. of useful air per minute will refine the charge in twelve minutes, of which two minutes are required for the desiliconising period. The amount of powdered lime to be blown in is about 1200 kilos., for which the blower has available eight minutes. About 2½ kilos. of lime will therefore be delivered per second, which is not really much, as double this quantity can be blown in without occasioning trouble.

The author emphasises in considerable detail the advantages attending this practice and gives some tables in which the results of basic Bessemer blows with and without the lime additions to the air blast are compared, much to the advantage of the method he advocates. Altogether, less lime is used in the circumstances he describes than in the usual and highly fortuitous practice of adding it in lumps. The heat of the converter is, moreover, better maintained and more economically regulated. Finally, the yield in ingot metal per weight of pig iron, scrap, and ferromanganese charged is considerably increased, while, as there is in the aggregate rather less lime used during the process, the slag is richer in phosphoric acid, the bulk of which is in a very favourable "citric acid soluble" condition.

In conclusion the author points out that the new process allows of the use, in the converter, of pig irons containing appreciably higher percentages of silicon than it is now the practice to use, and that thermo-chemical dependence on this additional silicon will have the effect of reducing substantially the amount of phosphorus which needs to be present in basic pig iron required for the basic Bessemer process. This widening of the nature of the pig iron is such as to allow of there being produced in the blast-furnace a wider range of suitable pig irons from a wider range of available (and lean) ores, and should serve to render it possible to revive basic Bessemer practice in localities in which the ores at present available have hitherto been regarded as unsuited.

* The latter part of the argument advanced by Monsieur Bicheroux reminds one forcibly of an experiment made as long ago as 1879 by the late Dr. J. E. Stead, which proved conclusively not only that phosphorus can be eliminated during the progress of decarburisation, but that the phosphate of iron formed as a result of the reactions can be at once removed, provided free lime is available, at the right time and in the right place, for it to combine with.

Conference on Rail and Road Transport.*

As members of the Conference on Rail and Road Transport, which presented its unanimous Report on July 29th last, we have now had an opportunity of considering the criticisms which have been made on that Report. Some of the criticisms have revealed certain misconceptions, and we consider that some explanatory comments are desirable.

One misconception, to which we admit that a few ambiguous words in one paragraph of our Report give some colour, needs at once to be removed. It was no part of our task to recommend, and we did not recommend, any new rates of licence duty for *passenger* vehicles of any class. The recommendations are limited to commercial goods vehicles.

Many of the criticisms proceed upon the assumption that the basis of our recommendations of new rates of licence duties was a consideration of the charges borne by the railways. It has been suggested, for example, that there is some relation between a table given in paragraph 22 of the Report, showing certain charges on the railways amounting to £64 millions a year and the £60 millions taken as the share of the total annual road costs to be borne by mechanically propelled vehicles. On this assumption it has been naturally asked why we did not examine the conditions affecting railway costs. The answer is that this was no part of our task and that the assumption is completely false. Our task was to consider the incidence of contributions to highway costs. It is true that one of the objects of this was that the basis of competition between rail and road should be a fair one, but that only means that the element of unfairness resulting from any inadequacy in the contribution of any class of goods vehicles towards the cost of the roads should be removed. We were in no way concerned to bolster up the railway services by rates of licence duty which took any other consideration into account, and we did not do so.

We pointed out the indisputable fact that vehicles not using petrol escape the petrol duty and that therefore their licence duties must be largely increased if they are to make a fair contribution towards road costs. It was not our duty to propose rates with a view to either driving steam vehicles from the roads or keeping them there; we had to propose rates which represented a fair contribution to road costs, and whatever be the cost of coal it constitutes no contribution to road costs.

SPECIFIC CRITICISMS.

It has been objected that our figure of £60 millions is too high. We very carefully examined recent expenditure (which has largely exceeded this figure). We made full allowance for the extent to which the main transformation of the road system has for the time come to an end, and for the particular circumstances of the work undertaken partly to relieve unemployment. We heard evidence as to the present position and prospective needs. We were impressed with the imperative need of expenditure in connection with major improvements, level crossings, the strengthening of bridges, and the completion of by-passes already begun. We considered that it would be a gross waste of money to abandon work which has absorbed considerable money and will be quite useless unless completed, and we were particularly impressed with the grave harm which would be suffered by the commercial motor industry if economies in expenditure (of which they would perhaps be unlikely to get the full advantage in reduced rates of duty) were made by abandoning much-needed work or lowering the quality of the road surface. After giving careful weight to the facts, the evidence presented, and such considerations as we have just indicated, we all came to the conclusion that the figure of £60 millions was a reasonable one to represent the average annual expenditure for the work required in the period of five years ahead of us. We would at the same time call the attention of the motor industry to the importance of our recommendation that after five years there should be a review of the situation in order to maintain a definite relation between actual road expenditure and the contributions.

The principal opposition to our recommendations probably arises from the increases proposed for very heavy classes of vehicles. It is indeed generally recognised that a considerable increase for these classes is already overdue, because the present scales, which increase by gradations up to 5 tons, quite indefensibly stop at 5 tons, so that the 12-ton vehicle pays no more than the vehicle of 6 tons. But it is true that the actual increases we propose represent more than a mere continuation of the existing scales. The fact is that we are convinced, on the evidence, that the carriage of a given weight over a given distance involves more, not less, wear and tear of the roads, if it is in very large units. At the same time it is certain that it involves the consumption of less petrol. So far as this is economy in the untaxed cost of the petrol, it, of course, gives a sound economic advantage which we have no desire to penalise; but so far as it means an escape from its appropriate contribution to the road expenditure, it is a factor which we were bound to consider in recommending the rates of licence duty if we were to discharge our duty.

The rates we have proposed are based solely on this consideration. They are the rates we should have proposed if no existing competing interests had been involved.

Similar considerations apply to our recommendations as to vehicles which, because they use another motive power, escape petrol duty. It was no part of our duty to consider whether, on grounds of national policy on which as individuals we might have differing views, a concealed subsidy should be given to vehicles using a British fuel such as coal. Our duty was to state the contributions a given class of vehicle needed to pay if it was to pay its fair share of road costs, and this could only be done, in the case of vehicles escaping petrol duty, by making a suitable addition to the licence duty.

Some critics have proceeded upon the completely false assumption that we have proposed a system of licensing control calculated to assimilate control to that in operation as regards the railways and for the purpose of establishing equal handicaps. We have done no such thing. We have proposed only such control as we think desirable in the public interest and in that of the motor industry itself. We desire to emphasise the latter point. Representatives of the industry, both on our Conference and expressing themselves through the Road Haulage Association and otherwise, have described in strong terms, as did the Royal Commission, the unsatisfactory conditions which militate against a proper organisation of the industry, conditions which cannot be removed without the aid of some system of licensing control.

As to the specific proposals, those who read our Report carefully will see that the system we propose is an elastic one capable of adjustment to what may prove to be the actual needs. At its minimum it is a basis involving little actual restriction though making restriction possible should it prove necessary. And in order that policy should develop upon lines which are really in the interests of the public and the industry, we have proposed the most effective security—namely, the appointment of a Central Advisory Committee upon which all the relevant experience would be represented. In case there should be any misconception on this point, we desire to say explicitly that we contemplate that this Committee should include an adequate number of persons with direct experience of the commercial goods transport industry.

CONCLUDING COMMENTS.

In conclusion, we suggest that the interests directly affected by our proposals (the owners of commercial goods vehicles) would be well advised to give careful attention to the following considerations:—

(1) It is beyond dispute that large increases in the licence duties of vehicles of over 5 tons (the point at which the present scales stop) are inevitable.

(2) It is equally indisputable that all vehicles escaping petrol duty are failing to pay a contribution towards the cost of the roads corresponding to their use of them.

(3) The total increase on the present contribution of £21 millions is £2½ millions, and it is inevitable that the great bulk of this increase should fall on the classes mentioned in the two preceding paragraphs.

(4) Our recommendations involve no appreciable increase as regards some 80 per cent. of commercial goods vehicles.

(5) We recommend that after five years there should be a review of the situation in order to maintain a definite relation between actual road expenditure and the contributions.

(6) We have counted the whole of the petrol duty as a contribution towards road costs. If every conceivable deduction were made in respect of the points made by

* From a letter dated December 17th, 1932, from the members of the Conference on Rail and Road Transport (the Salter Conference) to the Minister of Transport.

our critics the effect would be much less than the contrary effect of the use of a principle which distinguished between licence duties and the petrol duty and excluded the latter as a part of the contribution to road expenditure.

(7) As regards licensing we have proposed a system effectively safeguarding the industry from restrictive regulations imposed without full consideration by a body including those who can express the point of view of the industry.

We suggest that the owners of commercial goods vehicles would do well to consider seriously whether, in view of all these considerations, they would not be ill-advised to attempt to secure the rejection of the scheme agreed in our Conference and to take all the chances of an alternative policy.

Town's Gas for Motor Vehicles.

THE use of town's gas as a fuel for high-speed internal combustion engines is by no means new. It has been employed for some time by the leading manufacturers of motor vehicles for "running-in" their engines, and during the Great War town's gas was resorted to on a considerable scale for the propulsion of vehicles originally designed to operate on petrol, in which case, the gas was contained in large flexible bags situated on top of the vehicle. The results of tests carried out at that time were quite satisfactory, and the thermal efficiency was of a high order. The chief difficulty which presented itself was the limited capacity of the storage space, which restricted the radius of operation of the vehicle. Until quite recently the storage of town's gas under pressure was impracticable owing to the weight of the containers being so great as to add materially to the deadweight of the vehicles to be propelled. As a result, however, of the advances which have recently been made in the manufacture of high-tensile steel alloys, bottles can now be produced which, after suitable heat-treatment, have a sufficiently high tensile strength to enable them to be employed for gas storage under very high pressures, and which have only a fraction of the weight of the containers hitherto employed for this purpose.

As an example, the experiments recently carried out by the Birmingham Corporation Gas Department upon a 20 horse-power Austin van, in which town's gas was used as the fuel in place of petrol, may be quoted. This vehicle is fitted with five steel cylinders, each 5ft. 10in. long by 8in. diameter, and having a free gas capacity of 350 cubic feet measured at normal temperature and pressure, with a working pressure of 200 atmospheres, or approximately 3000 lb. per square inch. Each cylinder weighs 110 lb. and the total weight of the equipment approximates 5¾ cwt. This weight has to be set against 1¼ cwt. represented by the petrol tank, petrol and fittings, giving a net increase ascribable to the use of gas of about 4¼ cwt. Trial runs made by this vehicle gave very satisfactory results, the gas consumption with a load of 15 cwt. in the van being about 21 cubic feet per mile, as against 1 gallon of petrol for 12 miles, on which basis 250 cubic feet of gas is equivalent to 1 gallon of petrol. The compression ratio for town's gas needs to be raised in order to obtain the maximum efficiency. In the van to which we have referred the ratio was increased from 4·6 to 1, to 5·6 to 1, but with engines specially designed for use with town's gas still higher compression ratios could be employed with advantage.

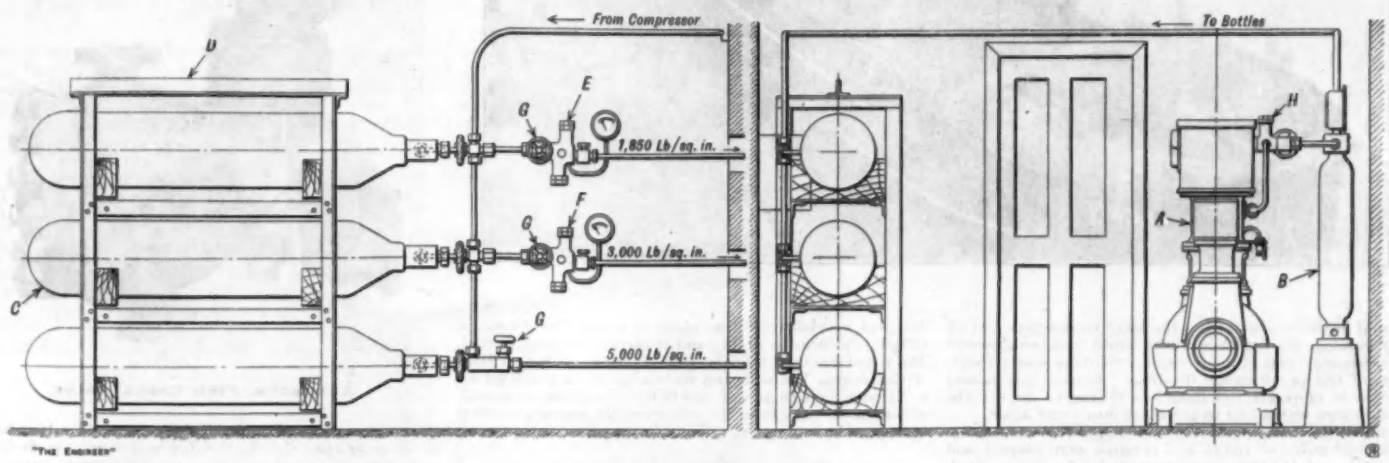
In the accompanying engravings we illustrate a special steam-driven compressor plant which has been designed by Belliss and Morcom, Ltd., Birmingham, for the purpose of compressing coal gas up to 5000 lb. per square inch for the propulsion of motor vehicles. In the drawing A is the compressing plant, B the separator column, C storage bottles, D the angle iron support for the bottles, E the automatic control and relief valve for a pressure of 1850 lb. per square inch, F a similar valve for the pressure of 3000 lb. per square inch, G, G, G stop valves for the supplies of gas at 1850 lb., 3000 lb. and 5000 lb. pressure, and H is a by-pass relief valve for the compressor.

The compressor is of the two-crank, four-stage type for an output of 10 cubic feet of free gas per minute, and is driven at a speed of 500 revolutions per minute by a single-cylinder vertical engine to which it is coupled direct. The gas is compressed in four stages with intercooling between each stage, and with a final-stage aftercooler coil, the cylinders and coils being surrounded by water in an open tank at the top of the compressor on which the gauges are mounted. Connections are provided for pipes to be led from all the packing glands and relief valves to the suction pipe line to prevent any gas leakage into the compressing room. The cooling is claimed to be very effective, as there is a rise of only 9 deg. Fah. between the gas inlet and final outlet when compressing to 5000 lb. per square inch. The power required at the compressor coupling is 7 to 8 B.H.P. A special feature of the compressor is the accessibility of the valves for examination without the necessity of breaking any high-pressure joints. Relief valves are also provided at each compression stage.

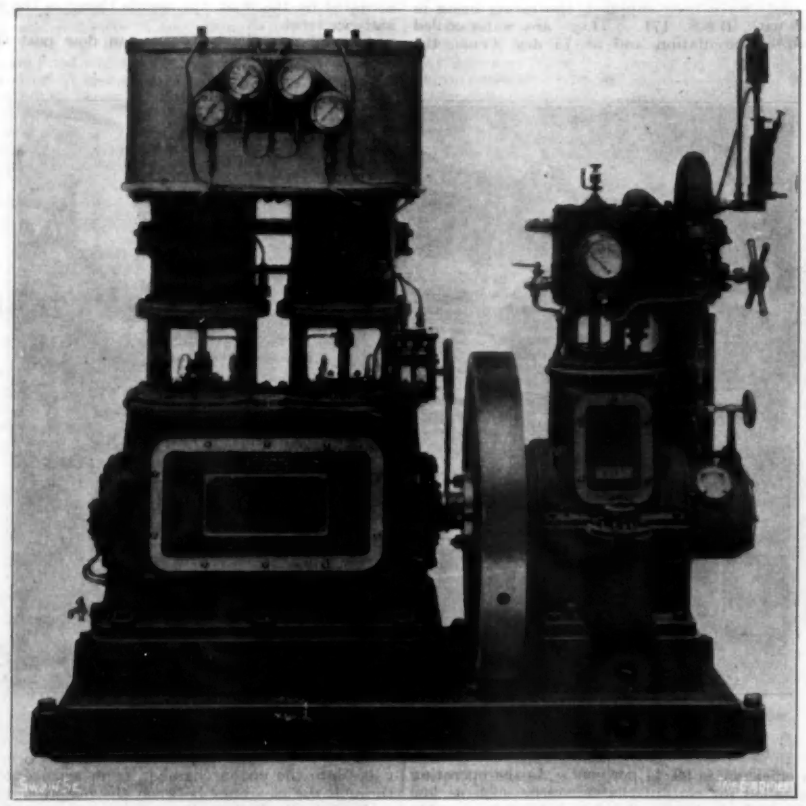
Plants similar to that described have been supplied to the Birmingham, Rotherham and Newcastle gas departments and to the Gas Light and Coke Company, and the Wandsworth and Wimbledon Gas Company.

The adoption of high-pressure town's gas for motor vehicles is at present restricted by Government regulations, and it is hoped that at an early date sanction will be given for high-tensile steel bottles of approved design to be employed in connection with passenger-carrying and other vehicles. These bottles are being made in this country by Vickers-Armstrongs, Ltd., from "Vibrac" steel, which contains approximately 2·5 per cent. nickel, 0·52 per cent. chromium, and 0·58 per cent. molybdenum, with a carbon content of 0·33 per cent. They are 6ft. 1in. long, 8in. diameter, have a wall thickness 0·19in. to 0·22in., a capacity of 1·76 cubic feet, a test pressure of 4500 lb. per square inch, and working pressure of 3000 lb. per square inch. The physical properties of this material are:

Yield point, tons per square inch	59·5
Breaking stress, tons per square inch	67·9
Elongation, per cent.	22·8
Reduction of area, per cent.	59·1
Bending test, angle turned through 180 deg.	Not cracked
Izod test, foot-pounds	53·5



ARRANGEMENT OF COMPRESSOR PLANT



STEAM DRIVEN GAS COMPRESSOR

Irish Land Drainage.*

THE important part played by drainage in the national economy of Ireland can scarcely be over-emphasised. Ireland has a most unusual and inconvenient contour formation. In most countries the higher lands are in the interior of the country and the ground falls away, either steeply or gradually, to the sea or to the great boundary rivers. In Ireland the hills form a ring near the coast and the centre of the country is flat. Consequently, the rivers have but little fall to the sea and it is difficult for the rainfall to get away quickly enough to obviate flooding. The central plain is, in fact, to a great extent, waterlogged, and contains over a million acres of deep bog. The effect of this on the climate, on agriculture, and on the public health is easy to understand.

If the rivers were opened up and graded sufficiently, and if the necessary local drainage were carried out, the whole country would drain itself. The historic Bog Commission of 1809–1814 carried out a very valuable survey of most of the bogs, and established the fact that at least 75 per cent. of the bogs, even the deeper bogs, could be drained by gravitation without the aid of pumping and without any great works of river improvement.

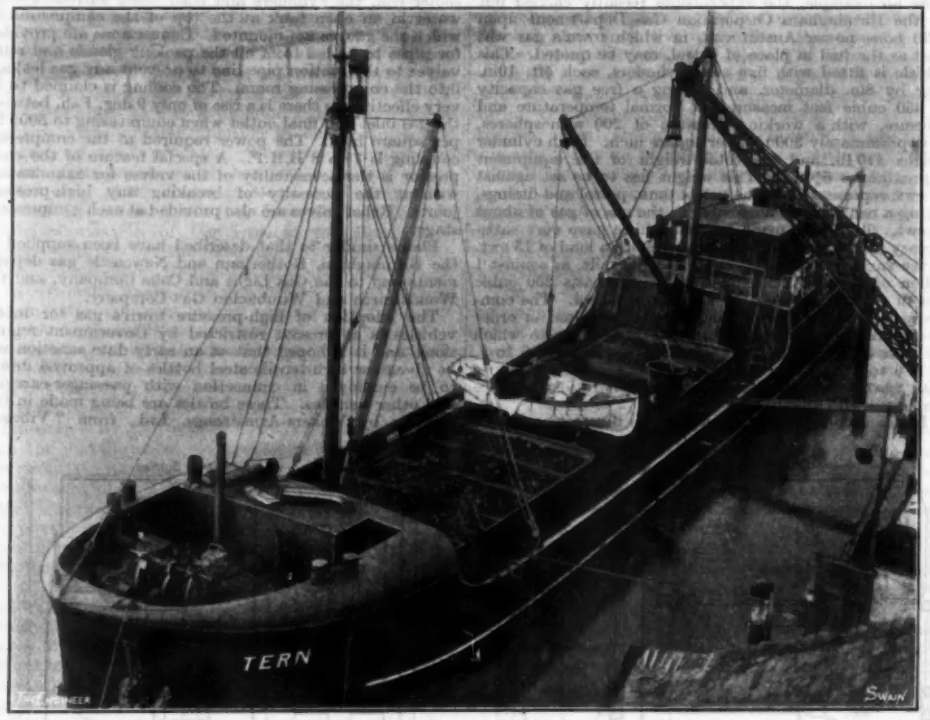
The Bog Commission's task was to explore the possibility of draining and reclaiming the bogs for agricultural purposes. But, quite apart from the bogs, there are large tracts of arable land which are periodically flooded, and it is this flooding which was the driving force behind the Government's actions in connection with drainage for the past century.

Arterial drainage and local drainage are both necessary to relieve flooding which is not in the immediate neighbourhood of the river channel. Arterial drainage would appear to come within the scope of the State's activities, but local drainage might more suitably be dealt with by the local councils.

There were two principal Drainage Acts during the nineteenth century. Under the Act of 1842, £2,390,612 was spent in various districts, and under the Act of 1863 an expenditure of £1,045,000 was incurred. The Great Famine practically killed the Act of 1842, and the transfer of the land from the old landlords to the tenants did the same for the Act of 1863. This was because the

* From Mr. Laurence Kettle's Presidential Address to the Institution of Civil Engineers of Ireland, December 5th, 1932.

SEA-GOING COAL-CARRYING BARGE



original initiative came from the large landowners. With their passing, the drainage works which had been carried out were neglected in many cases, and there was a recurrence of the pre-drainage flooding. An Act was passed in 1924 to empower the Board of Works to inspect the old drainage works and to get them into order again.

Under the 1924 Act £170,000 was spent on restoration work, 920 miles of rivers and streams were cleared and enlarged, and 111,500 acres of arable land was benefited. Employment was given in twenty-two counties, sometimes to as many as 2800 men.

With the view of providing for the initiation of new local drainage works the Act of 1925 was passed. Under this Act six rated occupiers can move in the matter of new drainage by petition to the County Council. The necessity for this Act is shown by the fact that in five years the Board of Works had 500 petition cases sent to them by the Councils. Under this Act work to the approximate value of £230,000 has already been undertaken, and an extensive programme is in preparation.

In 1926 an Act was passed to enable the Board of Works to complete the Owenmore Drainage, which had been started before the war by the Congested Districts Board. This work was finished at a cost of £71,000.

In 1927 the Barrow Drainage Act was passed and the work was commenced. This is almost entirely major arterial drainage. It is estimated to cost £425,000. In this connection a tribute should be paid to that talented Irish engineer, Dr. Chaloner Smith, who was the chief engineer of the Barrow Drainage. It is a national loss that he should have been called away in the midst of his activities.

The drainage work carried out in recent years justifies Mr. Olley's statement that "no such comprehensive arterial drainage undertaking to cover the whole of the Irish Free State has been directly set in operation by the Government during the past two generations." It is to be hoped that the good work will be continued and that in schemes for providing employment preference will be given to work such as this, which will prove beneficial and reproductive rather than to work of less certain value to the community.

Under the various Drainage Acts the lands which are benefited by the drainage are made contributory to the cost of the necessary works. For this reason the schemes already carried out were those likely to prove the most economic. The drainage which remains to be done cannot, in most cases, be paid for by the lands directly improved. As the country as a whole will derive substantial benefit from national drainage, State assistance is obviously justified. The Board of Works has an organisation and an experienced staff which has given good service to the country in the matter of drainage. With an augmented staff and with initiatory powers, this organisation is capable of much greater achievements.

It is suggested that a complete drainage survey should now be made of the whole country, and that estimates should be prepared of all the necessary works. If this information were obtained and recorded, and the works scheduled in order of importance, it would enable the Government to prepare a drainage programme for a series of years, working systematically towards the complete drainage of the Irish Free State.

Waterborne Coal.

AT the beginning of this month the vessel illustrated in the engraving above arrived at Messrs. Palmer's wharf at Kingston-on-Thames, with a cargo of house coal from Blyth in Northumberland. It is said to be the largest sea-going vessel that has ever navigated the upper reaches of the Thames. The ship, named "Tern," was designed specially for this class of work. Its length is 120½ft., its breadth 21½ft., and it carries 300 tons of coal. The vessel was built by Scheepswerf Gideon. J. Koster Hzn, of Groningen, Holland, and motive power is provided by a "Deutz" oil engine of 240 H.P. The direct shipment of coal in this way from the colliery to the consumer effects considerable economies.

Power Station Transformers.

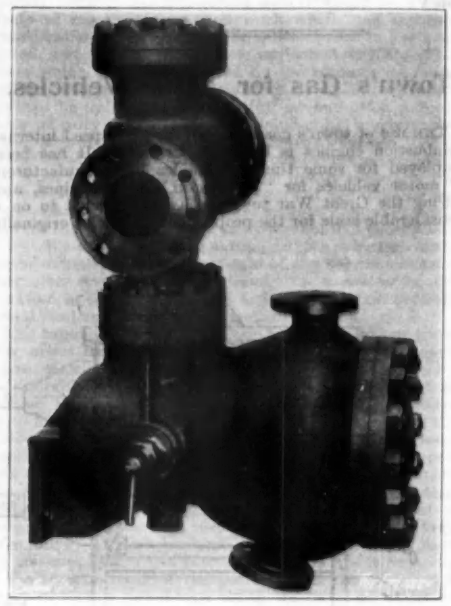
THE main step-up transformers, the local distribution transformers, and the auxiliary station transformers for the Battersea power station were all made by Ferranti, Ltd., of Hollinwood, and the accompanying illustration shows one of the main units in the course of construction. Three of these three-phase, 50 cycle, 80,000 kVA core-type 11/66 kV units have been supplied, the rating being in accordance with B.S.S. 171. They are water-cooled with forced oil circulation and at 75 deg. Cent., the maximum efficiency is 99·44 per cent. As the operating conditions called for certain characteristics such as low loss and limited reactance, the full maximum possible output could not be realised, but with an additional cooling unit it would be possible to raise the output to 110,000 kVA. Each of these transformers was delivered to the site complete in its oil-filled tank and impregnated and dried out ready for service. The remaining transformers consist of four 20,000 three-phase core-type units, with a ratio of 66/22 kV, fitted with on-load tap-changing gear, and three 6250 kVA three-phase transformers, with a ratio of 66/3·3 kV.

80,000-kVA 3-PHASE TRANSFORMER UNDER CONSTRUCTION

A Boiler Feed Water Regulator.

AN automatic feed check valve, the movements of which are effected hydraulically and are controlled by means of a float-operated needle valve is illustrated by the accompanying engraving. The device, made by G. and J. Weir, Ltd., of Glasgow, forms a single complete unit, which can be readily installed in either land or marine plants, with very little change in existing arrangements.

The automatic feed check valve is similar to an ordinary non-return valve. A piston works in a cylinder formed in the check valve casing above the valve itself. It is larger in diameter than the check valve, and is an easy fit in the cylinder. The discharge from the feed pump enters the regulator by a branch on the underside of the check valve, and after passing through the valve flows directly to the boiler. A passage through the check valve and piston allows water to flow from the feed pump discharge line into the chamber above the piston.



AUTOMATIC FEED CHECK VALVE

While the feed discharge pressure acts on the area of the underside of the check valve, and the boiler pressure acts on the top of the valve and the underside of the piston, the pressure acting upon the top of the piston is intermediate between those of the feed pump discharge and the boiler. It is controlled by a needle valve which is actuated by the float, the needle rising as the float falls, and *vice versâ*.

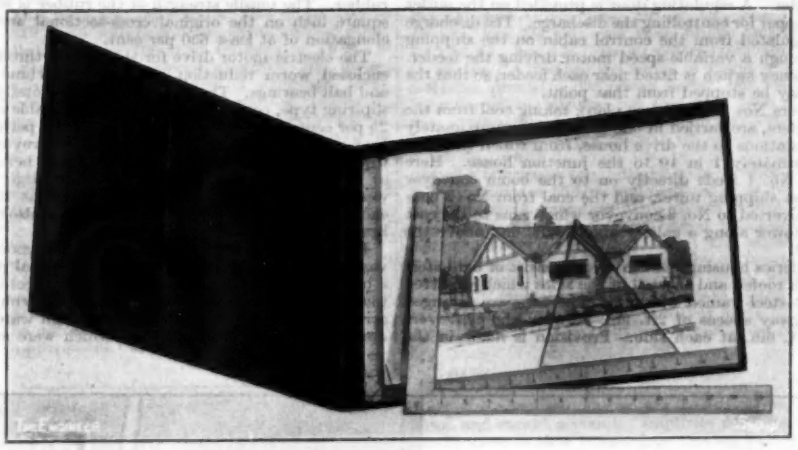
A small quantity of water can flow past the needle valve into the piston chamber, from whence it may pass through the clearance between the piston and the valve casing into the boiler. By varying the quantity of water passing the needle valve, the pressure in the chamber can be varied, so as to maintain the check valve in equilibrium in any desired position, demanded by the position of the float. When the float falls, owing to a fall in the boiler water level, the needle valve rises, cuts off the flow of water through the opening into the piston chamber, and the pressure in that chamber falls, owing to the leakage of water through the clearance between the piston and the cylinder. Immediately the water pressure in the piston

chamber falls below the pressure for equilibrium, the valve lifts and allows feed water to pass into the boiler. The valve can rise only the amount that the needle has been raised, because immediately the opening is uncovered the pressure on top of the piston rises above the pressure necessary to maintain the valve in equilibrium, and a closing movement of the valve takes place until the pressure in the chamber reaches the equilibrium value. Similarly, when the water level in the boiler rises, the needle is lowered by the action of the float, and the opening is uncovered, thereby allowing water to pass into the piston chamber, so that the pressure in this chamber rises above that necessary for equilibrium, and the check valve falls to the same extent as the needle.

The working water level in the boiler varies from a top level when no steam is being generated in the boiler, to a bottom level when the boiler is operating at its maximum rate of evaporation, and the feed regulator maintains a steady water level between the top and bottom water levels for any given rate of evaporation between no load and the maximum load. The float is contained in a casing which should be fixed as closely as possible to the boiler. This casing is placed in communication with the boiler by means of steam and water levelling pipes attached to the steam and water spaces of the boiler by suitable isolating valves.

The Drax Drawing Block.

WE illustrate herewith a handy drawing block, which is likely to be particularly useful on those occasions when no suitable table is available, since it can quite comfortably be used on the knee. It is made in two sizes, 8½in. by 11in., and 11in. by 15in., and consists of a thin

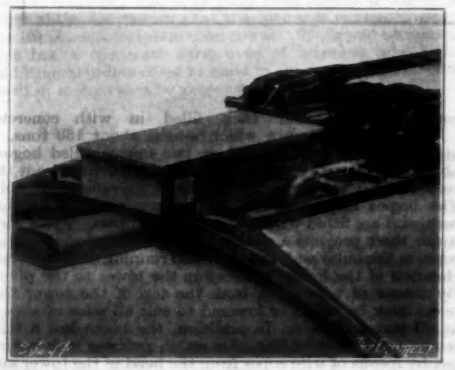


DRAWING BLOCK AND OUTFIT

box containing a detachable pad of drawing paper, an L square, and a 45–60–75 deg. triangle completing the equipment. At the left-hand and bottom edges of the pad there are fixed scales set at right angles to one another, and marked off in inches, so that as the L square is also so marked off no other rule is required. The use of the triangle allows lines to be drawn at 15 deg. intervals throughout a circle. The outfit is intended to provide an easily transferable drawing block by the use of which accurate sketches may be made. It is manufactured by S. C. and P. Harding, Ltd., of Alliance Works, Denmark-hill, London, and put on the market by the Drawing-office Material Manufacturers' and Dealers' Association.

Trolley Omnibuses and Wireless Interference.

IN view of the fact that users of wireless receiving sets have experienced considerable interference from trolley omnibuses and tramcars, the English Electric Company has introduced special choke coils for overcoming the trouble. Two of these coils are mounted on the roof of

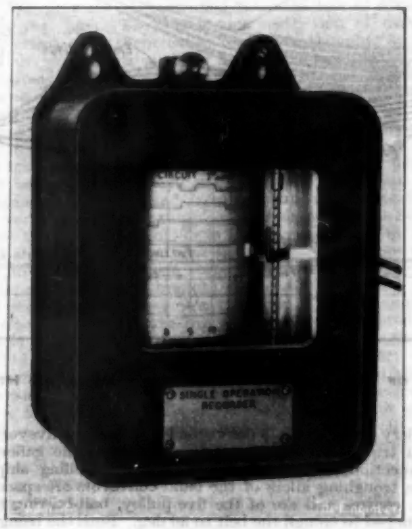


ANTI-INTERFERENCE CHOKE COILS

each vehicle in the manner shown in the accompanying illustration, and are connected in circuit with the two trolley arms which collect the current in the ordinary way. The total weight of the coils complete with their casing, is only 51½ lb., and it is obvious that they add little to the total cost of the standard equipment. It may be remembered that in order to overcome the interference from electrically propelled vehicles, the Tramway and Trolley Omnibus Broadcast Interference Committee was set up in April, 1931, at the instigation of the Post Office, which placed the services of its expert staff and equipment at the disposal of the Committee, whilst the transport and manufacturing concerns provided all other facilities. The introduction of these coils may be regarded as the first tangible outcome of the Committee's work, which has, apparently, led to very satisfactory results. Following the introduction of a fleet of sixty trolley omnibuses on the Kingston-Twickenham route of the London United Tramways, numerous complaints were received from users of wireless receiving sets, with the result that the tramway company appealed to the Committee to find some remedy. In due course eliminator coils were fitted to the omnibuses which were built jointly by the A.E.C. and the English Electric Company, and exhaustive tests showed that the coils were capable of reducing the interference to a negligible amount, even when six vehicles passed the place where the test wireless set was in operation.

A Single Operation Recorder.

A USEFUL instrument which will record the frequency and duration of any operation has been brought to our notice by Evershed and Vignoles, of Acton-lane Works, Chiswick, W.4. It consists of a single pen operated by means of a solenoid. On the chart there is a continuous spiral day line, and by means of a lead screw to be seen in the accompanying illustration the pen is made to follow this line. But if the circuit is closed, the operation of the solenoid causes the pen to draw a parallel line above the day line, and below it if the circuit is broken. When the chart is removed from the drum it gives a record covering a complete week, and a comparison of the operations on different days can be made at a glance. The drum on which the chart is mounted is driven by a simple eight-day



SINGLE OPERATION RECORDER

clock movement, giving a chart speed of ½in. per hour. The complete instrument is enclosed in a cast iron case, fitted with a hinged aluminium cover, which allows of easy access to all the parts. The instrument may be used in connection with pumps and other machines, cookers, refrigerators, water heaters, &c., and provides a useful check on the operation of automatic plant, as well as plant operated at intervals by hand. Multiple operation recorders on which seven, twelve, twenty or more operations can be recorded on a single chart are, of course, also made by Evershed and Vignoles.

Canadian Engineering News.

(By our Canadian Correspondent).

Favourable Economic Trends.

A RISE in wholesale prices in Canada during the first half of September is considered to be one of the outstanding favourable events in the Canadian economic situation. The rise is mainly confined to materials such as raw rubber, raw wool, silk and cotton, coal, chemicals, copper, lead, zinc, tin, and certain food commodities. Another good sign is the disposition of agricultural classes to come into the market for farm implements. During the recent Canadian National Exhibition at Toronto, farm implement manufacturers sold more products and received more real inquiries than they did in 1931. One leading manufacturer reported sales increases to have reached 100 per cent., with prospects touching a 500 per cent. advance.

Another Bridge Over the St. Lawrence.

A new traffic bridge over the St. Lawrence River, which will link the Island of Montreal, near Lachine, a suburb of Montreal, with Caughnawaga on the mainland to the south, is shortly to be constructed by the Provincial Government of Quebec, at a cost of approximately 3,000,000 dollars. The new bridge, plans for which have been completed, will link up with the highway running to Malone in the State of New York.

Large Electric Boilers.

Some large installations of electric boilers are being made in plants of pulp and paper makers in the province of Quebec. The announcement relates to installations on lines served with power by the Shawinigan Water and Power Company. A 55,000 horse-power electric boiler has just been put into full operation at the Wayagamack mill of the Consolidated Paper Corporation, Ltd., at Three Rivers. It will supply up to 120,000 lb. of steam per hour, or nearly sufficient to operate the entire mill. Another 55,000 horse-power electric boiler has been put into operation at the paper mill of the Anglo-Canadian Pulp and Paper Mills, at Limoilou, near the city of Quebec. This is the second unit of this size in operation in the Anglo-Canadian mills, and the two electric boilers together supply up to 240,000 lb. of steam per hour. Still another electric boiler of 33,000 horse-power capacity has been installed in the plant of the St. Lawrence Paper Mills Company, Ltd., at Three Rivers, and was put into operation about November 1st. The above-mentioned additional units on the system of the Shawinigan Water and Power Company will bring the total capacity of the electric boilers installed up to 525,000 horse-power.

Canadian Pitch for France.

FOR the first time in the history of the port, Montreal is exporting pitch in quantity, and recently the Norwegian steamer "Sveigen" departed with a load of 3000 tons of this commodity to be discharged at Havre, France, the shipment being made by the Dominion Tar and Chemical Company. It is reported that there is a shortage of pitch for making fuel briquettes in France and Spain, and recently a large number of Norwegian steamers of small burden, capable of navigating through the St. Lawrence canals, have been loading pitch at Great Lakes ports, both in Canada and the United States.

Growth in Metal Refining.

Only a few years ago the larger part of Canada's metals were shipped abroad in the raw or partly treated state, to be refined in England or in foreign countries. To-day almost all metals produced in the Dominion are refined here. There are seven copper smelters, which feed three refineries whose capacity is ten times the annual consumption of copper in Canada and is equal to the demand from the whole Empire. Even more striking are the cases of nickel, lead, zinc, aluminium, and cobalt, to say nothing of gold and silver, all of which are produced in refineries that lead the world in equipment and technique. Thus, in less than one generation, Canada has advanced from the position of a purveyor of raw minerals to foreign smelters and refineries, to a prominent position in the supply of refined metals.

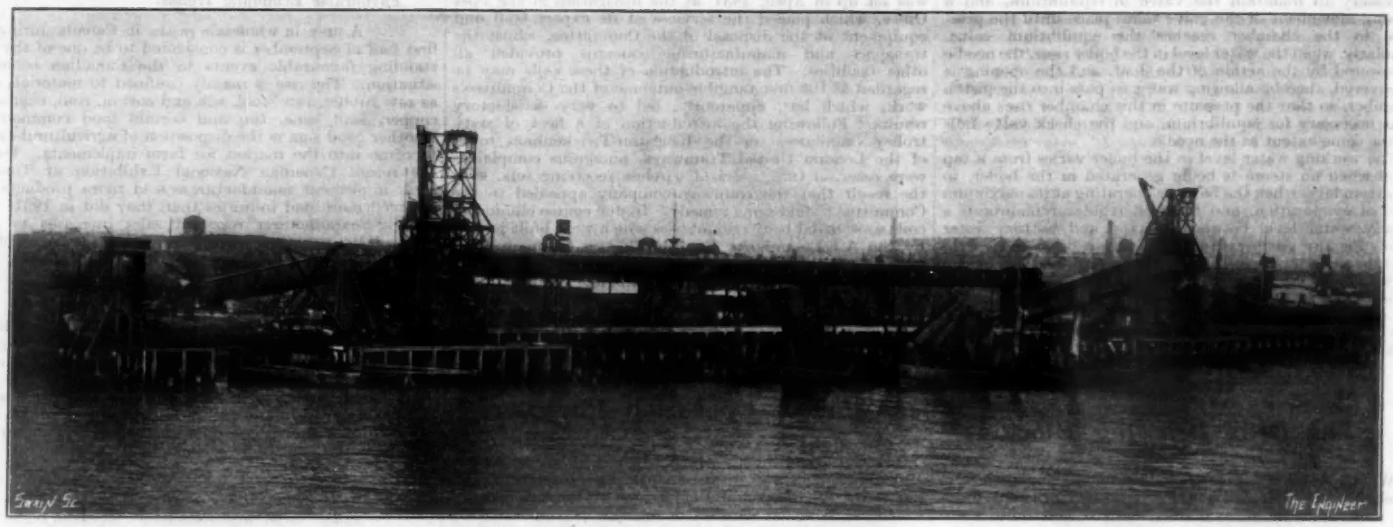
Tin-plate.

The import figures for the past fiscal year on tin-plate and black sheets for tinning are interesting. In sheets, coated with tin, n.o.p., total imports into Canada were valued at 3,252,369 dollars. Of that total, 3,046,017 dollars' worth came from the United Kingdom and 205,839 dollars' worth from the United States. Under sheets, cold rolled, for use in the manufacture of sheets coated with tin the figures show that the whole importation valued at 1,642,355 dollars during the year came from the United States. Under the new Imperial trade agreements there is a duty of 15 per cent. on black sheets imported from the United States for tinning, as against 10 per cent. formerly. British sheets of this type are now admitted free, whereas they were formerly subject to a duty of 5 per cent. Production of galvanised sheets in Canada during the first nine months of 1932 totalled 22,363 net tons, as compared with 34,126 tons in the corresponding period of 1931.

Lumber.

Lumber production in Canada this year has been the smallest in the history of the industry. Those mills which have not been closed have been running on a part-time basis, and there has been little demand for their output. Western Canadian mills have been shut out from the United States markets since June, when a duty of 4 dollars per thousand feet came into effect. Lumber prices at mills are lower than they have been for a quarter of a century, although the cost of production is greater, largely because timber limits are now a longer distance than formerly from points of manufacture and transportation.

NEW COAL STAITH ON THE TYNE



New Coal Shipping Staith at Howdon-on-Tyne.

In order to increase the facilities for the shipment of coal in that part of the river Tyne near Northumberland Dock, the Tyne Improvement Commission has constructed a new coal shipping staith, comprising two berths, for large vessels, which we illustrate herewith. It was opened on December 16th by Mr. H. P. Everett, the Chairman. Thereabouts the river has a depth of 25ft. at low water and 40ft. at high tide. The site of the staith, which has a frontage of 740ft., is on the north bank of the river near the west, or up-river end, of Northumberland Dock, about 3½ miles from the harbour entrance. The staith will be used preferentially by the Hartley Main Collieries, Ltd., by which the necessary standage sidings are being constructed, but it will also be available for the shipment of coal from any other collieries.

The plant consists of two travelling shipping towers on a wharf at the riverside, fed by belt conveyors from teeming hoppers into which incoming wagons discharge from the high-level railway sidings. Provision has been made for a third travelling shipper to be installed between the two existing towers, should future developments show this to be necessary.

Full standage accommodation is being provided for 3680 tons of coal in 20-ton wagons, with a future possible extension to about 5440 tons, while empty standage is provided for about 90 wagons with a possible extension to about 120 wagons. The full wagons gravitate to the discharging hoppers from the standage sidings, and empty wagons gravitate away from the hopper into the empty standage sidings. The full wagons discharge through bottom doors into two teeming hoppers, marked on the plan, from which the coal is fed by means of jigging feeders on two 42in. belt conveyors about 210 yards long and running towards the river wall. One belt feeds directly to the west shipping tower on the river front while the other discharges on to a belt running parallel with the dock wall and feeding a similar tower 460ft. to the east.

The jigging feeder at the outlet of each hopper is so arranged that when it is at rest the coal will be on the floor of the feeder. A regulating door is provided on the outlet of each hopper for controlling the discharge. The discharge is also regulated from the control cabin on the shipping tower through a variable-speed motor driving the feeder. An emergency switch is fitted near each feeder, so that the motors may be stopped from that point.

Conveyors Nos. 1 and 2 (see plan), taking coal from the jigger feeders, are carried in one gallery on approximately level foundations to the drive house, from which they rise at approximately 1 in 10 to the junction house. Here conveyor No. 1 feeds directly on to the boom conveyor of the west shipping tower, and the coal from No. 2 conveyor is diverted to No. 3 conveyor which runs to the east shipping tower along a gallery about 28ft. 6in. above the deck level.

The galleries housing the conveyors consist of light steel framework roofed and sheeted at the sides which are fitted with large steel-framed windows. The belts are arranged with gangway spaces of 2ft. 9in. between the conveyors and of 2ft. 6in. at each side. Provision is made in the gallery housing No. 3 conveyor for a future conveyor belt and tripper running on the river side of the gallery in connection with the proposed third travelling shipper. The troughing idlers of the band conveyors are spaced at 4ft. centres and are of the five-pulley, ball-bearing type, arranged to trough the belt to 30 deg. Both the troughing and return idlers have 5in. diameter pulleys, and are fitted throughout with nipples for grease gun lubrication. Take-up screws are provided for the adjustment of each of the belts. The return run of the belt is protected from falling coal by means of light steel sheeting running the full length of the conveyor, and a chain-driven brush gear is fitted to the return run to remove all coal, &c., adhering to the belt.

The coal is diverted through a right angle at each end of of No. 3 conveyor, by means of radial totally enclosed chutes designed to receive the coal without shock and to deliver it at approximately belt speed, so reducing breakage to the minimum.

The belts are made up of six uniform plies of at least 32 oz. duck, with a strength of 400 lb. per inch width of warp and 211 lb. per inch width of weft. The top cover is of rubber, $\frac{1}{8}$in. thick, while the bottom cover is $\frac{1}{16}$in. rubber. The tensile strength of the rubber is 4000 lb. per square inch on the original cross-sectional area with an elongation of at least 650 per cent.

The electric motor drive for the belts is through totally enclosed worm reduction gear, with machine-cut teeth and ball bearings. The motors are of the totally enclosed, slip-ring type, continuously rated, and capable of carrying 25 per cent. overload for two hours, or 100 per cent. overload momentarily. The whole of the conveyor galleries, towers, &c., are electrically lighted, current being supplied at 110 volts for this purpose, and two large 1000-watt weatherproof cargo clusters are provided at the ends of each loading boom. The control cabins are also electrically heated.

Each shipping tower, together with its associated conveyors is capable of handling 500 tons of coal per hour at a belt speed of 350ft. per minute. In the erection of these towers it was found that solid foundations could only be arrived at at a depth of 100ft. below high water, so they are supported on steel cylinders which were sunk under compressed air and then filled in with concrete.

Each shipping tower, which weighs about 180 tons, is of lattice steel work, carried on two four-wheeled bogies, about 30ft. apart, one bogie being power driven from the control house to provide the radial movement of 90ft. The bogies run on special 112 lb. per yard flat-bottom rails, and are fitted with screw-down stoppers. From each tower there projects a sliding loading boom slung by wire ropes at the outer end, the inner end running on the bottom channels of the bridge connecting the tower to the pivot. By means of wire ropes from the top of the tower this boom may be raised or lowered to suit all sizes of vessels at all states of tide. In addition, the boom has a telescopic movement of 50ft., for which purpose it is hauled out by means of wire ropes from the head of the tower and recedes by gravity. The radial bridge between each tower and the pivot carries a short conveyor at a higher level than, and feeding on to, the loading boom conveyor.

Coal is delivered from the end of the boom conveyor through a circular spout operated by a parallel motion arrangement, so that the spout is maintained at the

ARRANGEMENT OF NEW COAL STAITH AND SIDINGS AT HOWDON-ON-TYNE

same angle, regardless of the angle of the belt itself. A ball-bearing roller path is provided, so that the spout may be rotated freely by hand through a complete circle, and the spout is of light construction with this object in view. On each tower is erected an electrically controlled 12-ton jib crane for dealing with the anti-breaker spout, and having separate motors and controllers for the hoisting, luffing, and slewing motions.

Coal can be loaded at a maximum height of 61ft. above high-water spring tides, and at a maximum distance of 55ft. beyond the edge of the quay, or into small craft close alongside the quay. Power-driven Handcock anti-breakers are provided at each shipping tower, and all possible precautions are taken to prevent breakage of coal wherever transfer from one conveyor to another is necessary.

The whole of the plant is electrically driven, three-phase, 50 cycle A.C. current, at 440 volts, being taken from a sub-station on the site. The whole plant is controlled from the cabin situated high up on the river side of each tower. The controllers are capable of starting the plant against full load, and a sequence device is fitted to ensure that the motors can only be started up and stopped in the correct sequence. Telephonic communication is provided between the driver's cabin on each radial shipping tower and the teeming point, where the wagons discharge into the hoppers, also between the two driving cabins. Emergency switches are placed at the teeming hoppers, and at all points where the coal is transferred from one belt to another, so that the plant may be stopped from any of these points. Once stopped, it cannot be restarted by the driver until the switch has been reset.

The decking of the jetties is carried on 60ft. ferro-concrete piles, and is protected on the river side by timber piling and fendering. Access to the dolphins from the dock wall is provided by means of timber-decked gangways carried on ferro-concrete piles, and a motor road has been constructed between the west end of the dock wall and the main road from Howdon to North Shields.

Water mains have also been laid so that ships may be provided with fresh water, and fire-extinguishing appliances supplied. Besides the river frontage of 740ft., at which two vessels can be placed alongside and loaded simultaneously, there is also a tier of moorings, 480ft. long, at the east end of the staith for waiting vessels.

The scheme has been designed by Mr. R. F. Hindmarsh, M. Inst. C.E., engineer-in-chief to the Tyne Improvement Commission, in consultation with Mr. C. A. Nelson, managing director of the Hartley Main Collieries, Ltd., while the details of the reinforced concrete work have been prepared by L. C. Mouchel and Partners, Newcastle-upon-Tyne. The contract for the foundations and jetty work has been carried out by Brims and Co., Ltd., of Newcastle-upon-Tyne, and the conveyor plant has been installed by F. Turnbull and Co., of Newcastle-upon-Tyne. The electrical portion of the equipment was manufactured by the British Thomson-Houston Company, Ltd., of Rugby. The necessary dredging has been carried out by the Tyne Improvement Commission.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Preparing for Xmas Break.

WHILE business on the Birmingham Iron and Steel Exchange this week has been very quiet, there has been considerable activity in manufacturing works in the Midlands and Staffordshire. Industrialists were eager where possible to clear current orders and to complete all work in hand before the week-end when the Christmas break commences. To this end overtime had to be worked in some of the factories, while in others additional hands were employed. Stocks of material at the works have been pretty well used up, and as in the majority of cases the works will be idle for the whole of next week, fresh supplies have not as yet been negotiated for. At a large number of establishments stocktaking will be proceeded with during the holiday, and machinery repairs and replacements will be made in readiness for the resumption of activities. The attendance on 'Change in Birmingham this week was small, and conversations related mainly to transactions likely to be put through after the holidays. Producers of iron and steel were curious as to the possible requirements of their usual customers over the first quarter of the New Year, but the latter hesitated to give any definite guidance. In some cases, however, contracts have been placed to cover the first three months, so that the future is evidently clearer to some manufacturers than it was. Work will be resumed on but a moderate carry-over of business, and unless additional orders come to hand in the interim the vacation will in many cases be prolonged.

Raw Iron.

Demand for Derbyshire, Northamptonshire and North Staffordshire pig iron has been poor this week, and specifications against existing contracts have been on a smaller scale than of late, owing to the fact that consuming works were anxious not to get on to their premises more material than was necessary to complete this week's work, and enable a recommencement to be made after the Christmas vacation. There has been no alteration to the general conditions ruling in the industry or to selling rates. Blast-furnacemen find themselves at the end of the year in a reasonably favoured position, and, moreover, prospects for the coming year are, to say the least, encouraging. The main concern of furnacemen at the moment is the heavy stocks of material in their yards. Were it not for these the outlook might be considered to be good. These accumulations, however, will have to be reduced before the industry can claim to be in a really firm condition. In Northamptonshire stocks are larger than in Derbyshire or Staffordshire. Current market rates as fixed by the Central Pig Iron Producers' Association are on the basis of £3 6s. for Derbyshire No. 3 foundry, £3 1s. for forge, and £3 2s. 6d. for Northamptonshire No. 3 foundry, and £2 17s. 6d. for forge.

Finished Iron.

No development has taken place in regard to the finished iron trade in Staffordshire, and works close down this week-end in most cases for a full week. Orders for all classes of bar iron have fallen off during the past fortnight, but ironmasters who have thin order books hope for a revival of purchasing before the mills resume operations. Endeavours will be made to get some accumulation of business on which to recommence, and it depends upon the success of these efforts when a restart will be made. Current demand is poor in the Crown and common bar branches, and moderate in the marked bar and strip departments. Naturally, there has been even less business than usual about this week, and there was little market interest in finished iron. Producers have made no change in their selling prices on the week, and it is highly probable that they will remain at the present level at least until the first quarterly meeting of the Midland iron trade in January. Quotations are: Marked bars, £12; Crown bars, £9 upwards; nut and bolt bars, £8; fencing bars, £7 15s., and wrought iron gas tube strip, £10 7s. 6d. to £10 10s. per ton delivered. Belgian No. 3 iron, which competes with Staffordshire common bars, is slightly easier on the week, but there is apparently no call for it at date.

Steel.

The market for structural steel continues very slow. Rolling stock builders are also very short of contracts, and their demands for raw material are limited to very small tonnages. This week's call has been below the normal of recent weeks on account of next week's holidays. Selling prices are held at the Association fixed level. Angles are £8 7s. 6d., less 15s. rebate to users of British steel only; tees, £9 7s. 6d., less 15s.; joists, £8 15s., less 22s. 6d., and ship, bridge and tank plates, £8 17s. 6d., less 15s. Boiler plates command £8 7s. 6d. to £8 10s. A further reduction in prices of Continental steel has proved a disturbing factor, but, as far as can be gathered, no business has this week been done in this area at the reduced rates. Small steel bars were on 'Change in Birmingham to-day quoted by importing merchants at £6 7s., which is some 13s. per ton below the figure named a few weeks ago. Angles were on offer at £6 7s. 6d. to £6 9s., joists at £5 15s., and plates at £7 2s. 6d. Re-rollers in this district maintain their selling figure at £6 15s., which they claim to be the lowest remunerative level. Foreign billets are quoted round £5, which compares with £4 17s. 6d. to £5 7s. 6d. asked by native makers. The development of the situation is being watched with interest. Midland steelmasters have some reserve of orders, but in total tonnage it leaves much to be desired. Attention is now being directed towards the New Year.

Galvanised Sheets.

Galvanised sheets are selling slowly, alike on home and export account. Inquiries continue numerous, but business is slow to develop. Selling prices are firmly held on the basis of £10 for export, and £11 5s. delivered for the home trade. Values of black sheets are likewise unchanged on the week.

Tube Investments, Ltd.

At the thirteenth general meeting of Tube Investments, Ltd., at Birmingham, Mr. Arthur Chamberlain, the chairman of directors, pointed out that they had found the year 1932 no exception to the recent record of trade depression and inertia. The company's turnover and profits were both less than those of the previous year, but the directors recommended the same rate of dividend as a year ago. The continuous restriction of markets and prices gave them cause for much thought, and he laid the company's position before the meeting in considerable detail. Amongst the points of special general interest were a reference to the precision tube trade, expansion of trade in which he said was very unlikely. The company already supply about nine-tenths of this market. The only way to get an expansion of turnover in this, the most important of their departments, was by finding new uses for tube or new work for their tube plant and organisation. They had been working at this problem for some time, and examples of their successful efforts were the marketing of True Temper and Apollo steel golf shafts, and Pel tubular furniture. Other lines were yet in the development stage. With reference to the electrical accessories branch, the chairman stated that the reward of efficiency was tangible. The consumption of electricity was increasing, and those who offered the public good value for their money in electrical accessories should be assured of a long and useful existence. The importance of this branch of their manufacture should increase. As regards the company's manufacture of cycle fittings and articles of similar character, this group had more than maintained its turnover and profit. Of the firm's general prospects he hazarded the guess that provided trade got no worse, they would steadily, if slowly, improve on their present position. Any revival of trade would accelerate the rate of improvement.

Death of Mr. J. W. Dugdale-Bradley.

The death occurred at his home, Edgbaston, Birmingham, on Saturday, of Mr. James William Dugdale-Bradley, who, as a civil engineer, attained a position of eminence that led to his being consulted by Governments in other countries, including Canada, West Australia, Victoria, New South Wales, Nigeria, Brazil and Argentina. For twenty-two years, until 1923, when he retired on pension, Mr. Dugdale-Bradley was chief engineer and architect to the Westminster City Council, and for sixteen years was chairman of the Management Committee of the London County Council Schools of Art, Techniques and Cookery, Westminster. In addition to being a life member of the British Association, and prominently connected with British engineering organisations, he was a member of several Continental engineering bodies.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Concentrating Production.

A MAJOR consequence of the formation a little over twelve months ago of Textile Machinery Makers, Ltd., a combine with a capital of nearly £3,500,000 and embracing six of the leading firms of textile machinery manufacturers in Lancashire, is the concentraton of production at the works of three of the constituent concerns. The plan has recently been decided upon, and will be applied gradually. Operations will be suspended temporarily at the works of John Hetherington and Sons, Ltd., Manchester, Dobson and Barlow, Ltd., Bolton, and Asa Lees and Co., Ltd., Oldham, although sufficiently large staffs will be retained to continue the supply of spare parts, and the supply will also be maintained of special machinery made by these firms. The works at which operations are to be concentrated will be those of Platt Brothers and Co., Ltd., Oldham; Brooks and Doxey (1920), Ltd., Manchester; and Howard and Bullough, Ltd., Accrington. In the words of the official notification of these plans, the policy has been dictated by the present reduced demand for textile machinery, and in order to realise the full measure of economies which the formation of the merger has rendered possible. It is possible that in the long run the new arrangements will not involve any very considerable displacement of labour. On the contrary, the hope has been expressed during the past week that the concentration may eventually lead to an increase in the number of persons employed.

An Early Opening of the Mersey Tunnel?

At a meeting of the Liverpool City Council, at which it was decided to confirm the promotion of a parliamentary bill to secure further borrowing powers for the completion of the new Mersey tunnel from Liverpool to Birkenhead, Sir Thomas White, the Chairman of the Tunnel Committee, stated that provision had been made for the opening of the tunnel earlier than 1934 by the use of temporary ventilation, if the engineers could satisfy the Committee that the cost of the temporary ventilation plant would be covered by the receipts. In reply to a question, Sir Thomas said that every means had been taken to solve the problem of ventilation, and to make certain that the means provided would be effective for the purpose.

Running Motor Omnibuses on Creosote Oil.

A saving in fuel costs of about 30 per cent. is one of the facts which emerges from the experimental running of motor omnibuses on creosote oil as a fuel. The experiments were started about a year ago by the Salford Corporation transport department, and several of the older type single-deck vehicles have been adapted for the consumption of creosote oil, and have been running on every-day services. Mr. J. S. D. Moffet, the general manager of the department, whilst expressing satisfaction with the results attained up to the present, acknowledges that there are still slight difficulties to be overcome. The probability is that the department will convert all its old type omnibuses to the principle of using creosote oil, and on the wider results it will be possible to decide whether or not creosote oil should be generally adopted. From the point of view of pulling power, the creosote oil driven omnibus has proved to be equal in efficiency to the petrol-driven omnibus, although the former has been found to be less responsive to the throttle, and, moreover, care has to be taken when using the accelerator. Many of the early difficulties that were encountered, including excessive deposition of carbon, oil dilution and naphthalene crystallisation, have been virtually overcome.

£175,000 Textile Machinery Order.

It is understood that Tweedales and Smalley, Ltd., of Castleton, near Rochdale, one of the leading Lancashire firms of textile machinery makers outside the combine, have secured an overseas order for textile machinery of the value of £175,000. The firm in question is already one of the best situated from the point of view of order books, and the present contract will add materially to the work it has in hand.

Presentation to Retiring Locomotive Works Manager.

Mr. J. W. Smith, for twenty-six years works manager at the Gorton, Manchester, locomotive works of the London and North-Eastern Railway Company, has retired after a total of forty-seven years of railway service. Presentations were made to Mr. and Mrs. Smith on behalf of his many colleagues by Mr. H. N. Gresley, chief mechanical engineer of the company, last Friday evening. Mr. Smith estimates that nearly 14,000 locomotives were reconditioned at the Gorton works during his period of managership. In addition, 328 new locomotives were built there.

Europe's Largest Locomotive.

A Beyer-Garratt articulated type of locomotive, 109ft. long, 17ft. high, and 260 tons in weight, has been completed at the Gorton, Manchester, works of Beyer, Peacock and Co., Ltd., for the Russian Government. The locomotive has a fuel capacity of nearly 16 tons, a tank capacity of over 8000 gallons, and a boiler grate area of 86 square feet, with an hourly fuel consumption of about 3 tons. The locomotive was packed in separate sections, and its transport from Gorton to Liverpool for shipment to Russia was effected by the London and North-Eastern Railway Company on Saturday. It is said to be the largest and heaviest, as well as the most powerful, locomotive ever constructed in Europe.

Non-ferrous Metals.

After the sharp reaction in all sections of the non-ferrous metals market, with the exception of spelter,

a week ago, the price position on balance for the past week is somewhat steadier in each instance. In copper there has been no noticeable improvement in the volume of business, and the industrial demand has been generally confined to small parcels. In the early part of the week pressure to sell was rather strongly in evidence, but this was less pronounced later on, and notwithstanding the fact that the exchange value of the pound has been moving steadily upward, copper has registered an advance compared with a week ago of about 15s. per ton in standard brands, with the tendency at the moment of writing relatively steady. The demand for tin has also been quiet, and current quotations are roughly £1 per ton higher on the week. The statistical position in the case of lead is less "bullish" than it was some time ago, and plentiful supplies of the metal are pressing rather heavily on the market. In spite of this, however, this section has moved up to the extent of 5s. per ton, largely in sympathy with copper and tin. As it has been for some time, spelter is about the firmest section of the market, and the fractional decline reported a week ago has been more than wiped out by the advance of about 7s. 6d. per ton since last report.

Iron and Steel.

Decidedly quiet seasonal conditions are ruling in virtually every branch of the iron and steel trade locally, and sellers report very little business in any section during the past week. There is, however, in evidence a feeling of hopefulness regarding prospects in the early part of next year, and this is not born altogether of year-end sentiment. On the contrary, in several directions conditions at the consumer's end are a little better, and some substantial orders for paper-making machinery and textile plant have been secured by firms in the district. Pig iron prices for delivery in the Manchester area are on the basis of 67s. per ton for Derbyshire and Staffordshire No. 3, 65s. 6d. for Northants, 62s. for Derbyshire forge iron, about 82s. 6d. for Scottish foundry, and 81s. for West Coast hematite. Steel prices generally are on much the same levels as were quoted here a week ago. With regard to foreign materials on this market, the dual influence of lower gold values on the Continent and the rise in the pound has been to reduce quotations for imported iron and steel materials here, but so far without effect on the volume of business.

BARROW-IN-FURNESS.

Hematite.

While there is no further improvement to report in regards to the hematite pig iron trade, it is satisfactory to note that the slight rise in the demand has been maintained. Signs of a definite and marked lift in the market are still lacking, and it is probable that the first indication of such a movement will be in the rise of prices, which are at rock bottom. Business is practically confined to home deliveries, and neither the Continent nor America are in the market yet, except for very small parcels. The steel works are taking a fair quota of iron at Barrow, and thus stocks are not allowed to increase. The iron ore trade is a little better, consequent upon the increase in output of iron, but it is stated that not far short of 200,000 tons of ore are on the surface in the district awaiting orders. Foreign ore is in quiet demand. The steel trade continues to be quiet, and fresh orders are required if the mills are to be kept going. Shipping is very quiet. Shipbuilding is also quiet, but there is a fair amount of activity in the engineering departments, considering the general condition in the country.

SHEFFIELD.

(From our own Correspondent.)

Influence of Holidays.

IN the local steel industry there has been a decline of business as a result of the holidays. Most of the big works have made arrangements to close down for a longer period than is customary in times of good trade, and this is the inevitable result of the reduction in the number of orders in hand. But the present position is regarded as purely temporary, and there is every confidence that the New Year will bring a return to the improved conditions noticeable in past weeks. Such optimism is modified by doubts as to the effect of such matters as the practical closing of the Irish Free State market and international uncertainty. At the same time manufacturers of special and light steels are confident that the better trade which they have enjoyed recently will be renewed.

Exports and Imports.

There was an increase of about 10,000 tons in the exports of iron and steel materials last month compared with the figures for the previous month. Improvements occurred in the export of thick plates, ferro-alloys, pipes, rails and wire, but there were reductions in special steels, sheets, galvanised sheets, railway wheels and sleepers. It is not expected that this month's position in regard to exports will be so satisfactory, but decided support for the prevalent optimism is to be found in the home market position. Actually, imports of iron and steel dropped to less than 58,000 tons last month, this total being probably the lowest ever recorded in modern times, being only one-seventh, for instance, of the total during October of last year. It appears that the foreigner has now practically lost the British market for his steel, and that as stocks in this country become exhausted local manufacturers will benefit considerably from the changed conditions.

Russian Trade.

Although nothing definite has yet resulted, Mr. T. Nightingale, Chairman of the Russian Trade Section of the Sheffield Chamber of Commerce, has been actively engaged in representing Sheffield's interests at various conferences in London called for the discussion of the Anglo-Russian trade agreement which is under the consideration of the Government. In view of the fact that several big contracts have been placed in Sheffield by Russia in recent months, the question has special local importance. Mr. Nightingale states that everything possible is being done to make known the views of industry on this matter, so as to ensure that definite steps shall be taken to procure a greater measure of trade with the Soviet.

Aircraft Steel.

A suggestion that the number of different types and grades of steel for aircraft purposes should be considerably reduced has been made in Sheffield by Lieut.-Col. H. W. S. Outram, Director of Aeronautical Inspection. It appears that in America the number of aircraft steel specifications is comparatively small, whilst in this country no less than about eighty specifications have to be dealt with. The principal reason for this position is that British aircraft and engine designers all make their own requirements a little different from those of other designers, whilst the manufacturers also have specifications to suit their individual ideas. Col. Outram points out that some difficulty might arise, through the multiplicity of similar specifications, if an emergency occurred requiring the production of material in great quantities.

The Lighter Trades.

Conditions in the tool trade are varied, some firms being fairly busy—apart from the holiday influence—whilst others are short of work. There is only a poor demand for tools for the engineering and shipbuilding trades, but fairly good business is being done in files, axes, forks, shovels, and agricultural tools. Orders for general cutlery and electro-plate have declined sharply, although there is still a good deal of work on hand for the cheaper classes of goods. Scissors makers are busy and the enormous production of safety razor blades is being maintained.

Business Changes.

John Nowill and Sons, cutlery manufacturers, Scotland-street, Sheffield, have purchased from the receiver the goodwill, trade marks, patterns, and samples of the firm of Frank Mills and Co., Ltd., Hanover Cutlery Works, Sheffield, which was established in 1876. Important developments are in progress at the factory in Sheffield of two well-known local firms manufacturing silver and plate—Fenton Bros., Ltd., and James Deakin and Sons, Ltd.—which became allied early in the present year. The developments include the addition to the Matilda-street factory of a department for pen and pocket knives and the installation of plant for making scissors and chromium plating.

Coal Winding Record.

What is believed to be a world's record for coal winding has been established by the Frickley Colliery, which has made 430 "draws" in as many minutes. The cage holds twelve tubs, each with a capacity of 11 cwt.

Water Schemes.

The Bakewell Rural District Council has invited tenders for constructional work in connection with the water scheme at Eyam. It is proposed to replace an unsatisfactory reservoir, and on the suggestion of the Minister of Health a new reservoir will be built so as to leave two of the walls extending slightly, ready for extensions when further reservoir capacity is required. The Hull City Council is promoting a parliamentary bill, the main clauses of which will empower the Corporation to obtain a supply of water from Farndale and other sources in the North Riding, and also to construct waterworks. The Keldgate Reservoir is also being enlarged by the Hull Authority.

Sewerage Works.

It is proposed by the Chesterfield Rural District Council to construct sewerage and sewage disposal works for the Coal Aston area, near Sheffield. The Wakefield Corporation has obtained the sanction of the Ministry of Health for loans required for the construction of three bio-aeration units at the Wakefield sewage works at Calder Vale. Tenders have been accepted provisionally.

NORTH OF ENGLAND.

(From our own Correspondent.)

Steel Trade Developments.

THERE is every prospect of steel manufacturers in the Teesside area becoming keen competitors in the market for light steel requisites. In the past they have chiefly devoted their efforts to the production of heavy steel, and the fact that a start has now been made with lighter manufactures is of considerable importance. Interesting developments are taking place at the works of the South Durham Iron and Steel Company and the Cargo Fleet Iron and Steel Company, where the manufacture has been commenced of special qualities of alloy and high-tensile steels to meet the requirements of the automobile and lighter engineering trades. Considerable quantities of these materials have been produced recently, and marketed with highly satisfactory results. New plant is being installed at both works, which will enable the production of an even wider range of special higher grade steels, and machinery is also being laid down so that they can be manufactured into the forms in which they are required by consumers.

Iron and Steel Trade Activity.

Usually in the few days preceding the Christmas holidays there is a perceptible falling off in business in the iron and steel trade, and buyers rest content until well into January. On this occasion, however, business has been put through in increasing volume, with little sign of the apathy which one might have expected. The outlook for the industry is regarded as quite bright. Inquiries now circulating are numerous, and in some cases large. Confidence in steady trade development is more pronounced, and there is a growing inclination to negotiate for delivery over periods ahead. Both the home and overseas demands are expected to expand.

Cleveland Iron Trade.

In the Cleveland pig iron trade there has, of course, been a tendency to delay deliveries until after the holidays, but business in the early part of the week was fairly brisk. Observant buyers have noted the rise in raw materials, and they have come on to the market for substantial quantities of iron for delivery up to the end of March. This implies a confidence in the stability of the market, which events will probably justify. There are now no alternative sources of supply from overseas, and it would create no surprise if ironmasters took a firmer stand in the matter of prices. For a long time past ironmasters have been producing at little or no margin of profit. Moreover, the elimination of foreign competition tends to strengthen their position. Small concessions are still made for Scottish and overseas trade, but for home business ironmasters adhere firmly to their fixed minima, viz., No. 1 Cleveland foundry iron, 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; and No. 4 forge, 57s.

East Coast Hematite.

Improved conditions are also reported in the East Coast hematite pig iron trade. Demand is expanding, and orders are held that will absorb the existing output for some time to come, as well as effect some slight withdrawals from stock. Producers are anticipating a further expansion of business after the holidays, when more active conditions are foreshadowed in the steel trade. The price of mixed numbers is strong at 59s., with No. 1 quality at a premium of 6d. per ton.

Iron-making Materials.

The foreign ore trade is still dull and featureless, but merchants will only consider prompt business at the quoted price of 15s. for best Rubio, c.i.f. Tees. Good medium blast-furnace coke is realising 15s. 9d. and upwards, delivered to North-East Coast works.

Manufactured Iron and Steel.

Business in semi-finished steel is expanding on an encouraging scale, and several contracts for deliveries over the next two or three months have been placed. There is not much activity in the finished steel sections at the moment, but an expansion of business is expected in the New Year. Prices are firmly maintained. Iron and steel scrap continues in good demand, and there is a threatened shortage of certain descriptions. A further rise in values is predicted. Borings are 23s. 6d.; steel turnings, 30s.; light cast iron, 35s. to 36s.; heavy cast iron, 37s. 6d.; machinery metal, 40s.; and heavy steel, 37s. 6d.

Big Contract for Darlington Firm.

The Cleveland Bridge and Engineering Company, Ltd., Darlington, has received a contract from the Middlesex County Council for the construction of a low-level sewer at Chiswick. The price is understood to be about £110,000. The work consists of about a mile and a half of sewer pipes, constructed by tunnelling under compressed air, and lining with cast iron and brick.

The Coal Trade.

Brisk conditions are the rule in the Northern coal trade. All the collieries producing steam coals report well-filled order books and few loading turns available until well into January. Prospects ahead are particularly bright. The increased quota for this month has been readily taken up, and full-time working conditions are expected not only to the end of the month, but for practically the whole of January. Bookings ahead are quite substantial, and with a strong home demand to be met there is no large surplus available for export. The increased import quota allowed by France and Belgium for domestic purposes has been helpful to the industry, and Italy continues to take large quantities from this district. In the Northumberland steam coal section all qualities are in sustained demand, and many pressing orders have diverted to January shipments. Consequently the tone in all descriptions is bright and cheerful, with prices holding to recent maximum indications. Best Northumberland steams for this or early next month are firmly quoted at 14s. 6d., with smalls at 8s. 6d. Tyne primes or similar are 13s. 6d., and smalls 8s. 6d. Prime Wears are scarce, and nominal in value at 16s. for large and 11s. for small. The Durham gas coal trade position is improving, although the recent extremely mild weather has been a check on the normal development of seasonal trade. Gas and other artificial heating has not been required to anything like the extent usually associated with late December. Most of the Durham collieries, however, are working more regularly than for some time past, and they are looking forward to a favourable start in the New Year. Best Durham gas coals are firm at 14s. 6d., with special Wear qualities steady at 15s. Secondary gas are in moderate supply at 13s. 3d. to 13s. 6d. The bunker coal trade is fairly busy, and collieries are anticipating a good forward business. Best descriptions are firm at 14s. 6d., and seconds steady at 13s. 3d. Coking unscreened and smalls are unchanged at 12s. 6d. to 13s. 3d. Trade continues active in all brands of coke. For export patent oven kinds are doing well, as are coke nuts, with a further demand for the latter from the United States. Much more gas coke could be sold if it were available. There are heavy bookings, and only odd lots are offered at 18s. 6d. for best qualities. Patent oven coke is 15s. 6d., superior grades 16s. 6d., and coke nuts 17s. to 18s.

SCOTLAND.

(From our own Correspondent.)

Holiday Influences.

ALREADY there is an end-of-the-year feeling in markets generally. Business is quiet and there is a distinct tendency to avoid the slightest unnecessary additions to stocks. Despite the proximity of the Christmas and New Year holidays, markets are devoid of any extra demand for supplies over the stoppage, which, in many cases, may be prolonged.

Steel.

Consumers of heavy steel still purchase sparingly, and demands are fewer than at the beginning of December, though, in a measure, this is due to the fact that many take an inventory of stocks at this season of the year. The general inquiry is not too encouraging, but there is a greater feeling of confidence in the market that, with the turn of the year, some definite improvement in business will be experienced.

Steel Sheets.

So far as the output of the lighter gauges of sheets is concerned, the position is fairly satisfactory. Export business is comparatively good, especially with Far Eastern markets. Heavy sheets are disappointing and galvanised descriptions, too, have an irregular and quiet demand.

Tubes.

On the whole, the demand for tubes is slow and below expectations, the only activity reported being in the hot-rolled seamless section.

Reduction Gear Units for Burmah.

Beckett and Anderson, Ltd., engineers and electricians, Glasgow, have just shipped to Burmah two large-powered reduction gear units for operating oil field pumps. Each unit is driven by two electric motors, and is capable of transmitting 875 B.H.P. The gearing is totally enclosed and is lubricated by a special pump housed within the steel gear case. This is the third order for similar gears for the same destination.

Iron.

The iron market is devoid of fresh feature. Short-time working is fairly general in both the bar iron and the re-rolled steel bars departments. Prices are unchanged, with re-rolled steel bars quoted at £7 5s. home, and £6 10s. per ton export.

Pig Iron.

During the past week there arrived in this district a consignment of 2450 tons of pig iron from Calcutta, and one of 400 tons from Workington. Home demands are easily met from stocks and the two furnaces now in operation. Hematite is now cheaper at 66s. per ton delivered local steel works, while foundry is unchanged at 70s. No. 1, and 67s. 6d. per ton No. 3 f.o.b. makers' works. Forge iron is also quoted 67s. 6d. per ton delivered local malleable works.

Coal Quota Increase.

The decision of the Central Council to grant an increase of 150,000 tons in the quota allocation to Scotland brings the authorised output up to about 78¼ per cent. of the standard basis.

Coal.

The scarcity of coal for export is still very pronounced. Many of the collieries are fully sold for this month, and in some cases well into January. West of Scotland round fuels have only occasional odd lots available, while Lothians and Fifeshire steams are practically unobtainable for shipment this month. Washed materials are almost as scarce. Considerable quantities of singles and pearls are being shipped to the Thames. Aggregate shipments amounted to 232,943 tons, against 241,438 tons in the preceding week and 273,772 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

FROM the point of view of shipments last week, the returns issued by the Great Western Railway Company were disappointing. The total of 398,130 tons was certainly better than the preceding week, when the quantity came to 369,815 tons; but still, the results were below what would have been achieved had the tonnage due to arrive put in an appearance. Unfortunately, the bad weather which prevailed delayed the bulk of the tonnage which had been chartered and at the end of the week the dock returns showed that there were thirty-six idle tipping appliances at the various docks. Further disappointment was in store for collieries, as a continuance of the gales meant that the loading position at the steam coal ports on Monday was by no means good. Instead of the number of idle tips being substantially reduced as the result of week-end arrivals, the situation was that between Newport and Port Talbot idle tipping appliances still ranged as high as thirty-four. Still, the tonnage has to come along, and the prospects are that there will be more loading pressure immediately before and after the holidays. Swansea, as has been the case now for some months past, started the week in a strong tonnage position, as on Monday the records showed that there were no idle tips, but seven steamers waiting to get into berth. From this it will be seen that the demand for anthracite continues to be very satisfactory. From the point of view of new business the conditions in steam coals remains without material alteration, and exporters have during the past few days concentrated their efforts upon getting their steamers loaded so that they can get away before the vacation. Here and there new orders have come on the market, but the volume of fresh business has by no means been a feature. If anything, contract operations have occasioned more interest, though this has not been on what may be considered a heavy scale. As was expected confirmation was received that the order for 50,000 tons of large and small coals for the Madrid, Zaragossa and Alicante Railway of Spain for delivery at Barcelona, Alicante, and Carthagena over the first six months of 1933, had been placed locally. It turns out that the business has been placed with about four firms. In the case of the Algerian State Railways' requirements of coal and patent fuel over next year, confirmation has yet to come that part of the order is being placed for Welsh fuel. Another order which is of value and interest to this district is that of the Egyptian State Railways for 60,000 metric tons of locomotive coal for delivery at Alexandria over the first three months of 1933. The quantity which firms are asked to tender for is much less than is usual at this period of the year. It is, in fact, lower by about 100,000 tons than was the case a year ago, which indicates that these railways are not prepared to commit themselves to a heavy purchase, much the same as other buyers, who prefer to go on a hand-to-mouth principle. Tenders were opened at Cairo for the 60,000 metric tons on Tuesday, but it will probably be after the holidays that the business will be definitely placed, as prices usually have to hold good for fifteen days.

Christmas Holidays.

The official holidays in the South Wales coalfield this Christmas time will be Monday and Tuesday next, the 26th and 27th inst. As regards work at the docks, the shipment of coal, &c., will be suspended at the ports under the control of the Great Western Railway Company on the same days, viz., Monday and Tuesday next week. Full operations will be resumed on the Wednesday, the 28th inst. Efforts are still being made at Swansea to get the local tippers to agree to some variation of working hours so as to enable the port to deal with periods of extreme pressure, but at a meeting of the Swansea Chamber of Commerce at the end of last week it was reported that these efforts had so far continued to be unsuccessful.

Iron and Steel and Tin-plates.

Work was resumed about the middle of last week at the Llanharry iron ore mine, and employment was provided for about 300 men, who had been idle for about four months. As previously mentioned, this has been brought about by reason of the British (Guest, Keen and Baldwins) Iron and Steel Company, Ltd., contracting for 2000 tons weekly for the next twelve months. This company brought a second blast-furnace at Margam into operation on Tuesday of last week, but the one operating at the Dowlais Works, Cardiff, is to cease, though the large furnace at Cardiff now being constructed is expected to be brought into operation in February next. The official announcement came at the end of last week that four of the six furnaces at the Cwmfelin Steel Works of Richard Thomas and Co., Ltd., are to be relighted immediately after the holidays, which is good news for Swansea workers. It is expected that the rolling mills will also make a resumption of work about a week later when supplies of steel are available. The Cwmfelin Steel and Tin-plate Works were closed down about three years ago. So far as can be gathered there is no intention of restarting the tin-plate side of the undertaking. It is also reported that the National Smelting Company is making plans for increased production of spelter in the New Year, which is likely to mean additional employment at Swansea, where this company owns works. Reference was made recently to the agreement come to between employers and representatives of the workmen in the tin-plate industry for the absorption of unemployed workers in mills and finishing departments which are operating. As the result of this it is expected that at least 500 unemployed tin-plate workers in West Wales will be able to make a restart early in the New Year. It was stated last week that Richard Thomas and Co., Ltd., and the Grovesend Steel and Tin-plate Company, Ltd., had agreed, subject to certain safeguards as to quality, &c., to apply the six-hour shift at works which are operating under the eight-hour principle, which means that this will allow four sets of men instead of three sets to operate in each mill.

Development Work.

Reference has been made on a previous occasion to the efforts which are being made to stimulate industry in this district, and in this connection the South Wales and Monmouthshire Industrial Development Council has set out to compile a comprehensive record of the industrial possibilities of this area, and as a first step all the local authorities have been circularised requesting all details of convenient sites, transport facilities, general services, &c., so that any inquirer for information on the subject can be readily supplied. In this connection it is also interesting to note that under the auspices of the Cardiff Chamber of Trade, a gathering of representatives of the various manufacturing firms in this district was held to consider means for the extension of trade. A number of constructive proposals were put forward by the Council of the Chamber, which included the formation of a manufacturers' section of the Chamber, the creation of a publicity pool, local and national, for Cardiff products, investigation of financial resources for development purposes, co-operation with the South Wales Regional Industrial Development Council and similar bodies with like aims, &c. The meeting approved in principle the tentative proposals laid before them and appointed a strong committee representative of the various types of product.

Egyptian State Railways Contract.

The lowest tender for the Egyptian State Railways coal requirements of 60,000 metric tons has been submitted by the Deutsche Kohlen at 23s., c.i.f. Alexandria, and 17s. 4½d. f.o.b. The lowest tender for Welsh coals is from T. Beynon and Co., Ltd., of Cardiff, at 24s. 3d., c.i.f. Alexandria, and 17s. 10½d. f.o.b.

Current Business.

New business for loading immediately before and after the Christmas holidays has been quiet, exporters and shippers realising for one thing that with so much tonnage delayed they will have all they can do to load and sail the steamers that are due. This applies more especially to cargoes which are of a mixed character, and most of them are nowadays. Demands can easily be met if they consist of large coals, as these qualities are standing in substantial quantities, but supplies of all grades of sized coals are scarce, and these are the descriptions which are most needed. Coke is a steady market and patent fuel is unaltered. Pitwood is restricted in supply, and prices range from 25s. 6d. to 26s. 6d., though these figures are largely nominal.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

FLAMEPROOF PLUGS AND SOCKETS FOR USE IN MINES.

No. 279—1932. This specification was first published over five years ago, its main object being to standardise the dimensions essential to secure interchangeability between plugs of different makes, without in any way impairing the flame-proofness of the apparatus. The present revised specification follows very largely the same lines as the earlier edition, but takes account of modifications in practice introduced during the intervening five years, and endeavours by suitable footnotes and otherwise to make it easy for the designers and builders of machines on which flame-proof plugs and sockets made in accordance with it have to be used to ensure that there will be no difficulty in securing "physical interchangeability of plugs of different makes." The provisions for interlocking the plug with its associated apparatus have been made clearer by being collected together into one clause, amplified by an Appendix on the interchangeability of the interlocking pin and socket.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE NATIONAL GAS ENGINE COMPANY, Ltd., Ashton-under-Lyne, will in future be known as the National Gas and Oil Engine Company, Ltd.

WALFORDS OVERSEAS, Ltd., asks us to say that after January 2nd, 1933, its business will be conducted from Abbey House, Baker-street, London, N.W.1. Telephone number, Welbeck 8537.

THE MAGNOLIA ANTI-FRICTION METAL COMPANY OF GREAT BRITAIN, Ltd., informs us that from January 1st, 1933, the address of its registered office will be 34, Victoria-street, London, S.W.1. Telephone number, Victoria 4702.

MR. ARTHUR DOCKING who was formerly associated with Premix Gas Plants, Ltd., has founded the firm of Arthur Docking and Co., Radiant Works, Johnson-street, Westminster, London, S.W.1, for the carrying out of industrial heating work in connection with Crossley Bros., Ltd., Openshaw, Manchester.

BOOTH, WILSON AND PETIT, of 64, Victoria-street, Westminster announce that the partnership is being dissolved by mutual consent on December 25th. Mr. H Cecil Booth and Mr. Charles W. Pettit will continue to practise at the above address in partnership under the style of Booth and Pettit and Mr. J. S. Wilson will practise independently, in the same building.

THE Committee of Lloyd's Register of Shipping announces the appointment of Mr. Malcolm K. Scott as assistant secretary. Mr. Malcolm Scott is a son of Mr. Andrew Scott, who has occupied the position of secretary to the Register for many years. Mr. Malcolm Scott is well known to many of the Society's clients, both at home and abroad, having paid visits on behalf of the Society to Belgium, France, Germany, Holland, Italy and Spain.

CONTRACTS.

LODGE-COTTRELL, Ltd., informs us that it has recently received the order for a blast-furnace gas-cleaning plant from the British (Guest Keen Baldwins) Iron and Steel Company, Ltd., for Margam Works. This plant is in addition to the firm's existing Halberg-Beth installation, and will have a capacity of 1 million cubic feet, measured at N.T.P., per hour. The guaranteed degree of cleaning is 0·02 grains per cubic foot.

ENGINEERS' GERMAN CIRCLE.—The last meeting of the autumn session of the Engineers' German Circle took place on Monday evening last, December 19th, at the Institution of Mechanical Engineers, when a lecture was delivered by Dr.-Ing. Willy Sichardt, of Berlin, on "Ground Water Lowering, and Chemical Consolidation of Subsoils as Means to Facilitate Foundation Work." The lecturer drew upon his very wide experience in these two fields of civil engineering work and with the aid of clear diagrams and lantern slides showed many examples in which constructional engineering work had been made possible by the application of these new methods. Of particular interest to his hearers were Dr. Sichardt's personal accounts of the chemical solidification work recently carried out at the Monument Underground Station in London, in order to facilitate tunnelling operations, and the deep well pumping plant which has been installed as a permanent part of the equipment at the Southern Railway Company's new graving dock at Southampton. In his concluding remarks the chairman, Dr. S. J. Davies, referred to the very wide range of subjects dealt with in the lectures arranged by the Circle, which not only provided an excellent exercise in the German language, but also brought engineers into direct touch with fields of work other than their own.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	15/6 to 20/–
(1) Spanish	17/– to 24/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	15/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 6 0	—
No. 1 Foundry	3 10 0	—
No. 3 Foundry	3 7 6	—
N.E. COAST—		
Hematite Mixed Nos.	2 19 0	2 19 0
No. 1	2 19 6	2 19 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold-blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry		—
No. 4 Forge		—
Basic		—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (*a*); 4 0 6 (*b*); 4 5 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	9 5 0	—
Best Bars	10 5 0	—
Double Best Bars	10 15 0	—
Treble Best Bars	11 5 0	—
LANCS.—		
Crown Bars	9 15 0	—
Best Bars	10 5 0	—
Hoops	12 0 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 0 0 to 9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 0 0 to 8 10 0	—
Gas Tube Strip	10 7 6 to 10 10 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.)	11 5 0—10 Ton Lots and Upwards Delivered Glasgow Stations.	10 0 0
„ (Gal. Cor. 24 B.G.)	For Canada	10 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 10 0	—
SHEFFIELD—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	5 15 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars (all British)	7 0 0 to 7 5 0	—
Small Re-rolled Bars	6 15 0	—
Billets and Sheet Bars	4 17 6 to 5 7 6	—
Galv. Sheets	11 5 0 to 13 5 0	10 0 0
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 7 6 to 8 10 0	—

NON-FERROUS METALS.

SWANSEA—		
Tin-plates, I.C., 20 by 14	f.o.b.	15/9 to 16/3
Block Tin (cash)		149 0 0
„ (three months)		150 10 0
Copper (cash)		28 13 9
„ (three months)		29 0 0
Spanish Lead (cash)		11 3 9
„ „ (three months)		11 11 3
Spelter (cash)		15 8 9
„ (three months)		15 8 9
MANCHESTER—		
Copper, Best Selected Ingots		34 5 0
„ Electrolytic		35 0 0
„ Strong Sheets		65 0 0
„ Tubes (Basis Price), lb.		0 0 10
Brass Tubes (Basis Price), lb.		0 0 9
„ Condenser, lb.		0 0 11½
Lead, English		13 5 0
„ Foreign		11 15 0
Spelter		15 15 0
Aluminium (per ton—raw ingot)	£95	

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/7½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 15 0	8/–
„ „ 6 p.c. to 8 p.c.	£24 10 0	7/6
„ „ 8 p.c. to 10 p.c.	£22 5 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£36 10 0	11/–
„ „ „ 1 p.c. carbon	£42 12 0	14/–
„ „ „ 0·70 p.c. carbon	£44 0 0	16/–
„ „ „ carbon free	1/– per lb.	
Metallic Chromium	2/9 per lb.	
Ferro Manganese (per ton)	£10 15 0 for home	
„ „ „	£9 15 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£13 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 10 0 scale 6/– per unit	
„ Vanadium	12/6 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£245 0 0	
Ferro Cobalt	7/9 per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	15/–
„ „ Ell	16/– to 16/6
„ „ Splint	16/– to 17/–
„ „ Trebles	15/– to 16/–
„ „ Doubles	12/6 to 13/–
„ „ Singles	11/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/6
„ „ Jewel	16/6
„ „ Trebles	15/6 to 16/–
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	13/– to 15/–
Screened Navigation	16/6 to 17/6
Trebles	17/– to 18/6
Doubles	13/6 to 14/6
Singles	11/6 to 12/–
LOTHIANS—	
(f.o.b. Leith)—Best Steam	14/–
Secondary Steam	13/6
Trebles	15/6 to 16/–
Doubles	12/– to 12/6
Singles	11/3 to 11/6

	ENGLAND. Inland.
(8) N.W. COAST—	
Steams	19/– to 23/6
Household	32/6 to 52/6
Coke	18/– to 22/6
NORTHUMBERLAND—	
Best Steams	14/6
Second Steams	12/6 to 12/9
Steam Smalls	9/6
Unscreened	12/6 to 13/–
Household	27/– to 39/–
DURHAM—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–
SHEFFIELD—	
Best Hand-picked Branch	27/– to 28/–
South Yorkshire Best	23/– to 24/–
South Yorkshire Seconds	18/– to 21/–
Derbyshire Best House	22/– to 23/6
Derbyshire Best Brights	18/– to 20/–
Screened Seconds	17/6 to 19/–
Kitchen Coal	16/6 to 17/6
Best Screened Nuts	17/– to 18/6
Small Screened Nuts	16/– to 16/6
Yorkshire Hards	17/– to 18/–
Derbyshire Hards	17/– to 18/–
Rough Slacks	8/6 to 9/6
Nutty Slacks	7/– to 8/6
Blast-furnace Coke (Inland)	10/– on rail at ovens
Furnace and Foundry Coke (Export), f.o.b., 14/6 to 15/6	

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	20/– to 32/–
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/– to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	20/–
Pitwood (ex ship)	25/– to 26/–
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 34/–
Red Vein	22/– to 26/6
Machine-made Cobbles	37/6 to 48/6
Nuts	36/6 to 48/6
Beans	28/6 to 32/6
Peas	19/6 to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/6 to 9/–
Steam Coals :	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 22/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Steel Cartel.

THE price of merchant bars at Antwerp reflects with fair accuracy the general state of the international market, and the fall this week to £2 13s. gold per ton f.o.b. shows to what extent political and other influences have weighed upon the steel industry. The Belgian and Luxemburg group did what it could to prevent prices from falling below what was stated to be production cost, but offers of French steel have been more insistent, with the result that all attempts to avoid a threatened collapse appear likely to fail. This possible contingency had the effect of inducing Belgian and Luxemburg steel producers to meet the French and German representatives in Paris on Saturday last with a view to resuming the discussion upon the reconstitution of the Steel Cartel. The fact that the Belgians attended this informal conference leads to the supposition that they have settled their own differences, for until all the Belgian producers were in agreement, the other members regarded it as hopeless to continue negotiations. Nevertheless, since the negotiations were broken off there have been changes in the respective countries, and the basis upon which the quotas of steel production are to be fixed is again the subject of discussion, the French claiming as a basis the production for the second half of 1931, while the Belgians insist upon the second half of 1932, and the Germans the second half of 1929. The Germans are holding out for their claim on the ground that the situation of the steel industry since 1929 has been quite abnormal, and that the steel outputs since then do not represent the normal possibilities of each country.

The Engineering Outlook.

The events of the past week have had a depressing effect upon all branches of industrial activity. It had been hoped that the efforts of the Government to provide employment and create a little more confidence by releasing money to carry out its programme of public works would have had at least some appreciable influence upon the engineering trades, though no one expected too much, and while the new Government may continue the task of its predecessor, there will necessarily be further delay in voting the money for public works and in finding some way out of the financial difficulties. Manufacturers appear to have an unpleasant feeling that their plank of safety has slid from under them. In any case, the public works upon which so many are pinning their faith, can have but a partial effect upon trade, and the only other hope for the engineering industries is to profit from the loans granted to countries on the understanding that those countries will pass some of their orders for material on to French makers. This has had some good effect, and contracts are in hand for Central and Eastern Europe. But the value of such work is nothing like proportionate to the amount of money lent. The lending of money has come to an end. It is found to involve too much risk, and the financing of foreign enterprises is more difficult than ever. Nevertheless, some foreign business is being done, and the Société Française des Travaux Publics has secured a contract to the value of 3,000,000 gold pesos for an extension of the port of Mar del Plata in Argentina. The intervention of the French Government in Bulgaria over the question of the agreement between that country and Germany, whereby German firms would supply railway material to be paid for by Bulgarian tobacco, has had the effect of securing for France, which is also a purchaser of tobacco, some of the Bulgarian requirements in rolling stock. An office has been created to facilitate such exchanges between the two countries.

Commercial Exchanges.

Six months ago all exporting industries were grouped in a Union which is preparing an International Congress to be held in Paris in April next. The exporting industries of all countries will be asked to send delegates to discuss the ways and means of reducing progressively fiscal tariffs and removing barriers to commercial exchanges. It is proposed to do this by educating the public all over Europe to the vital importance of freer trade conditions, and by putting pressure on the respective Governments to take into account the interests of exporters when negotiating commercial treaties. This activity of the exporting industries is the most curious feature of the situation at the moment. It is creating a current of opinion in favour of removing trade barriers, and has evoked official sympathy with the movement, but there is besides an equally powerful union of industrial interests which claims adequate protection, and there may be a considerable conflict of opinion before the Government will be able to settle upon an acceptable compromise. In any case, the chances of this country meeting other nations in the way of tariff reductions are more promising than they have been for a long while past.

Gustave Eiffel.

On the occasion of the centenary of the birth of Gustave Eiffel at Dijon his bust was unveiled last week at the base of the Eiffel Tower in the presence of a large and distinguished company. Monsieur Léon Guillet, Director of the Ecole Centrale, where Eiffel was a student, spoke of his achievements which are seen in many noteworthy bridges and other constructions in France and abroad. His popular fame will, of course, always be associated with the tower which was constructed for the Paris Universal Exhibition in 1900, and was to have been demolished at the end of ten years, but the tower has served a useful purpose for scientific observation, and was employed by the late General Ferrié for wireless experiments before and during the war. It will continue to be used for wireless telegraphy, though for broadcasting its future seems to be in some doubt. In 1913 Eiffel installed at the base of the tower the first wind tunnel for experiments in aero-dynamics, and he devoted most of his time, until his death, to this phase of aviation at a larger and more complete laboratory he laid out at Auteuil during the war.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

383,207. May 26th, 1932.—HIGH-PRESSURE STEAM GENERATORS, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

In the case of single-tube boilers there is a tendency, in the event of the load being suddenly increased, for the pressure in the boiler to drop, with the consequence that steam is produced by the stored heat, and "slugs" of water are shot out of the boiler to the detriment of the machinery. The inventors consequently insist on making the boiler tube at least 10,000 diameters long. At the same time arrangements are provided for regulating the

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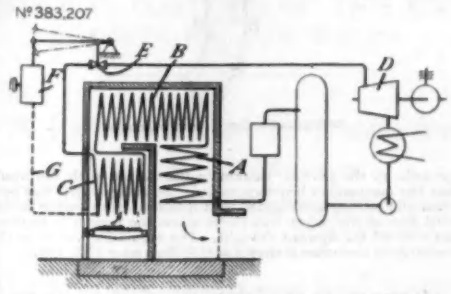

rate of flow of the water and steam through the boiler, so that steam bubbles are prevented from adhering to the tube walls, whereby corrosion phenomena are prevented. The boiler comprises the feed-heating section A, the evaporative section B, and the superheater C. Steam is supplied to the turbine or other prime mover D, from which the condensate is returned to the boiler. At E there is a throttle in the steam pipe under the control of the device F. This device communicates with the boiler by means of the pipe G, and in the event of a sudden demand for steam occurring prevents the pressure drop in the steam generator becoming dangerous.—*November 10th*, 1932.

INTERNAL COMBUSTION ENGINES.

383,519. March 29th, 1932.—DOUBLE-ACTING TWO-STROKE ENGINE, Scott's Shipbuilding and Engineering Company, Limited, East Stewart-street, Greenock; A. Rennie, 63, Eldon-street, Greenock; and A. E. Fothergill, 10, Ardgowan-street, Greenock.

In this engine the exhaust port A is uncovered by the piston before the scavenging port B on account of its greater length.

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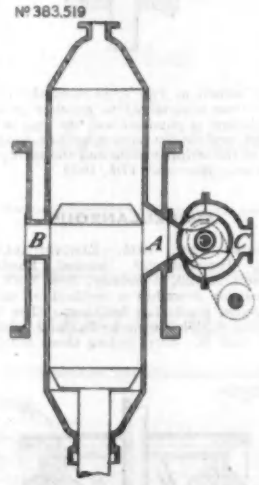

The result is a thorough exhaust and scavenge. On the compression stroke the rotary valve C closes the exhaust passage simultaneously with the covering of the scavenge port by the piston, so that the amount of the air represented by the travel of the piston until it reaches the edge of the exhaust port is entrapped and compressed, instead of being blown out through the exhaust.—*November 17th*, 1932.

DYNAMOS AND MOTORS.

383,339. August 31st, 1931.—DYNAMO-ELECTRIC MACHINERY, Allgemeine Elektricitäts-Gesellschaft, of Friedrich Karl-Ufer 2/4, Berlin, N.W.40.

This invention is particularly concerned with the anchoring of the end connections of the windings of rotating field magnets. The end connections A are secured against the action of the centrifugal forces by bands B, which are subdivided and are separated from the frame by the insulation C. If this insulation lies directly on the rotor body D or on a part rigidly connected with it, then during the travelling of the end connections, owing to expansion of the winding, it would slide to and fro on the support and be violently pulled. In order to prevent this, the insulation does not rest directly on the rotor body D, but on a steel carrier ring E. This ring is displaceable axially relatively to the rotor in both directions in accordance with the expansion of the winding. The end connections A and their insulating supports C are, however, so held together with the stiff carrier ring E by the pressure of the band B that relative alterations in position between the ring and the insulation lying upon it cannot take place, and these parts are only movable as a whole on the rotor body D. In order to ensure play of the carrier ring E on the body of the rotor as free from friction as possible, means for reducing the friction resistance, such as steel balls or rollers, are inserted between these parts and are mounted in recesses in the rings, and serve to guide and

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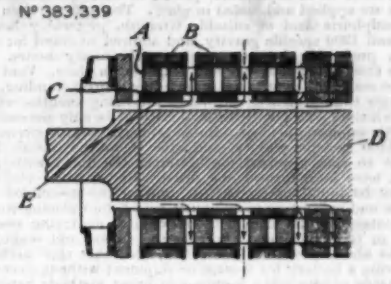

centre the carrier ring. The ring E is secured against movement in the circumferential direction by means of screws or keys.—*November 17th*, 1932.

383,371. October 8th, 1931.—DYNAMO-ELECTRIC MACHINES, Allgemeine Elektricitäts-Gesellschaft, of Friedrich Karl-Ufer 2/4, Berlin, N.W. 40, Germany.

The cooling medium of a machine constructed in accordance with this invention is circulated in the manner indicated by the arrows. The iron of the rotor and the stator is subdivided in each case into three parts A B C and D E F respectively. Between these parts there are radial exhaust channels G H and J K respectively for the cooling medium. The fan L sucks the cooling medium through the inlet opening M and supplies it first to the end chamber N. From there a part of the cooling

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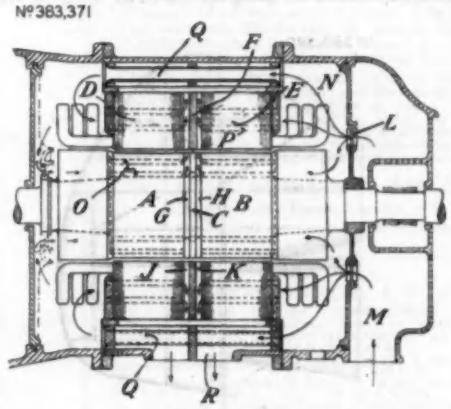

medium goes through the axial cooling channels O or P, and escapes through the radial exhaust channels G and H into a collecting space. Another part of the cooling medium goes through by-pass tubes Q to the left-hand end chamber of the machine, and from there is distributed, in a similar manner as on the right-hand side, through the axial cooling channels O or P respectively of the rotor and the stator, in order finally to pass out through the radial exhaust channels likewise into the collecting space. From there the cooling medium is led through the exhaust outlet R to a recooling plant.—*November 17th*, 1932.

SWITCHGEAR.

383,576. June 17th, 1932.—LIQUID-BREAK ELECTRIC SWITCHES, International General Electric Company, Inc., of 120, Broadway, New York, U.S.A.

This invention relates to liquid-break switches in which the arc is extinguished in an extinguishing chamber, the liquid contained in the extinguishing chamber being preferably conductive. A is an extinguishing chamber, the lower part B of which is of metal. It is closed at its upper

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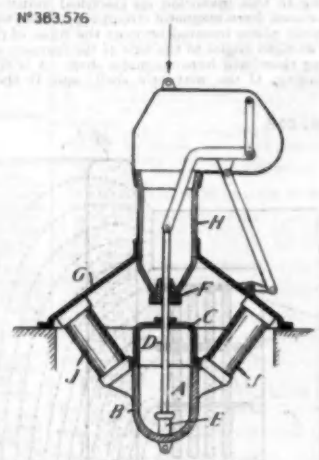

end by an insulating cap C with an aperture for the movable contact D. The lower part B of the extinguishing chamber contains the fixed contact E, which has a terminal. The movable contact D is guided by the guide F, and its movement is effected by means of the linked levers, as shown. The base-plate G is of conical shape, and forms at its apex a socket for the bushing H, and carries the insulators J, which are rigidly connected to sockets on the base and on brackets fixed to the extinguishing chamber.—*November 17th*, 1932.

BATTERIES AND ACCUMULATORS.

383,201. May 14th, 1932.—ELECTRIC ACCUMULATORS, The Chloride Electrical Storage Company, Ltd., of Clifton Junction, near Manchester.

For obvious reasons it is often necessary to store or ship

electric accumulators in closed containers, without electrolyte, and the new method for preventing deterioration of the plates is claimed to remove the various disadvantages of other methods. Unformed pasted plates are assembled into elements with wet treated wood separators, placed in their containers, and covers are applied and sealed in place. The cells are then filled with sulphuric acid of suitable strength, preferably between 1200 and 1300 specific gravity, and allowed to stand for a few hours, preferably between twelve and twenty hours. The acid is then drained off and vent plugs put in place. Vent holes may be sealed air tight, since no gases develop on standing. The batteries thus prepared can stand for many months without deterioration. To put them in service, it is only necessary to fill with sulphuric acid of suitable strength, say, between 1150 and 1200 specific gravity, and give them the initial charge similar to that required for batteries assembled with plates which have been formed and dried. Under some conditions, it may be found preferable to immerse the assembled plate groups and separators in sulphuric acid before placing them in the containers, and then without washing or drying assemble them in the containers, applying the covers and sealing the cells as above described. It will be seen that this method of preparing a battery for storage or shipment without electrolyte eliminates certain steps required in other methods heretofore used, and is therefore less costly, and it prevents deterioration while standing without electrolyte. While the cells prepared in this way may be hermetically sealed, this is not necessary, and an ordinary vent plug provided with a small vent opening may be used for sealing purposes.—*November 10th*, 1932.

AERONAUTICS.

383,590. July 8th, 1932.—CONTROL SURFACES FOR AIRCRAFT, Sir W. G. Armstrong, Whitworth Aircraft, Ltd., and J. Lloyd, Whitley, near Coventry.

This rudder is of the servo-flap type. The rudder is shown at A and the flap at B. The flap is operated by the crossed rods C C and levers D D. These levers are connected with the rudder bar E by the cables F F and with the rudder by the links G G. These links include the spring boxes H H, the springs of which

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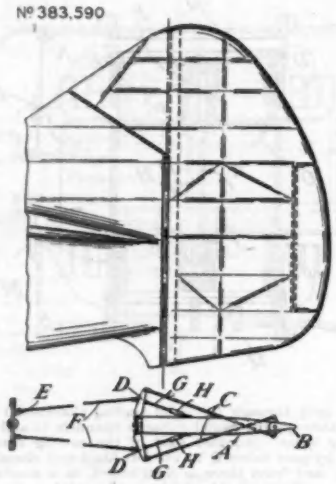

are under compression. When the rudder bar is pushed over the first effect is to move the rudder directly through the links G G. As, however, the deflection is increased the resistance of the rudder increases and the springs in the boxes H H are compressed. There is consequently a relative angular movement between the levers D D and the rudder, so that the crossed rods bring the servo-flap into operation. A friction device is introduced to relieve the pilot of continued effort if the rudder must be kept over for any length of time.—*November 17th*, 1932.

FURNACES.

383,058. November 10th, 1931.—INDUCTION FURNACES WITHOUT A CLOSED MAGNETIC CIRCUIT, Allmänna Svenska Elektriska Aktiebolaget, of Västerås, Sweden.

According to this invention an electrical induction furnace without a closed ferro-magnetic circuit is provided with annular ferro-magnetic plates inserted between the turns of the winding in a plane at right angles to the axis of the furnace, and around the winding there is a ferro-magnetic shell. A is the crucible, B the winding, C the magnetic shell, and D the magnetic

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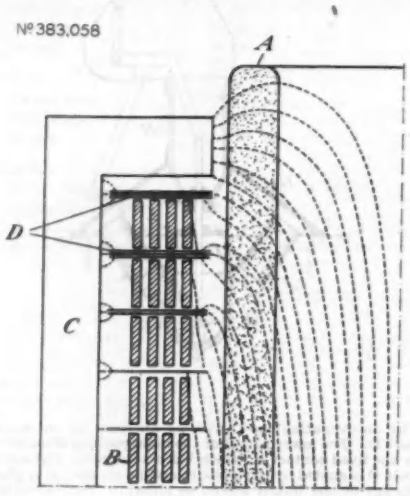

intermediary plates. Lines of magnetic flux are indicated by dotted lines, which show how practically all that flux which does not pass through the portion of the shell projecting towards the furnace is conducted through intermediary plates, which, therefore, contribute to an increase of the active flux in the furnace. At the same time they reduce the axial leakage and thereby the copper losses in a more efficient manner than hitherto.—*November 10th*, 1932.

383,598 August 18th, 1932.—DISCHARGE GEAR FOR ASH HOPPERS, *Babcock and Wilcox, Farringdon-street, London, E.C.4.*

With the arrangement shown, in which the ashes are quenched by the water sprays A, it has been found that when the ash hopper empties there is a tendency for moisture to be drawn

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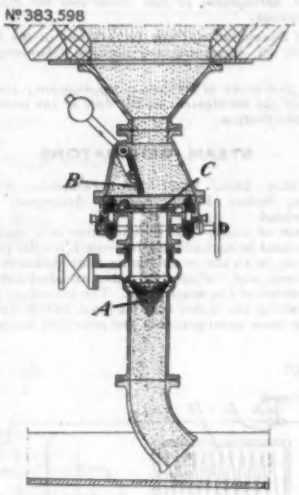

upwards by the partial vacuum in the ashpit, with the result that the mechanism becomes rusted. So a flap valve B is provided and so counterweighted that it is held open by the downward flow of the ashes, but closes when the hopper is emptied and cuts off the upward draught. The regulating valve for the discharge of the ashes is shown at C.—*November 17th*, 1932.

MACHINE TOOLS AND SHOP APPLIANCES.

383,487. February 8th, 1932.—FORGING RINGS, "Ringfeeder" G.m.b.H., Uerdingen, Niederrhein, Germany; and L. Bressler, 19, Topstrasse, Uerdingen.

This invention is concerned with the manufacture of ring springs by a pressing process. A disc or blank is first pressed,

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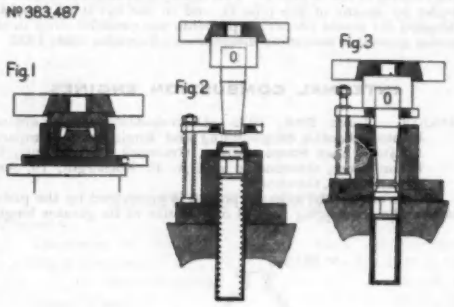


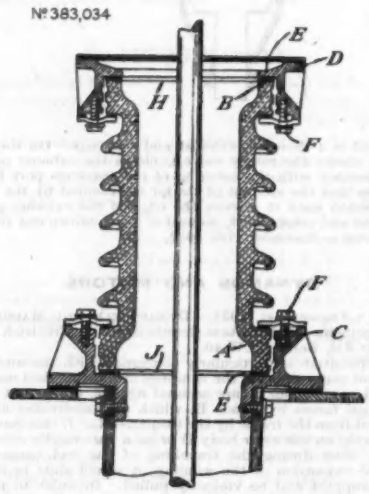
hot, in dies, as shown in Fig. 1, to form the ring with a diaphragm. It is then transferred to another press (see Fig. 2), where the diaphragm is punched out, the ring is expanded on a tapered mandrel, and finally formed by dies, as shown in Fig. 3. The operation of the stripper plate and the spring ejection of the swarf are obvious.—*November 17th*, 1932.

MISCELLANEOUS.

383,034. October 23rd, 1931.—ELECTRICALLY INSULATING BUSHINGS, International General Electric Company Incorporated, of 120, Broadway, New York, U.S.A.

This specification describes a method of making oil-tight joints on electrical insulating bushings. The lead-in bolt is surrounded by an oil-filled ceramic bushing, which is provided with flanges A and B. Surrounding these flanges are sockets

Nº 383,034



C, D, each provided with an internal radial flange E, between which and the adjacent outer end face of the corresponding bushing flange an oil-tight joint is made by means of suitable interposed packing H, J. The packing is compressed by a circumferentially distributed series of clamping bolts F. The space between the wall of the socket C or D and the outer circumferential face of the bushing flange may be filled with cement.—*November 10th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TUESDAY, DECEMBER 27TH.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Christmas Juvenile Lectures, "Round of the Water: (i.) The World's Water and its Form," Prof. A. O. Rankine. 3 p.m.

THURSDAY, DECEMBER 29TH.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Christmas Juvenile Lectures, "Round of the Water: (ii.) The Water in the Sea," Prof. A. O. Rankine. 3 p.m.

FRIDAY, DECEMBER 30TH.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "The Design of Kilns for the Seasoning of Timber," Mr. E. A. Steel. 7.30 p.m.

SATURDAY, DECEMBER 31ST.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Christmas Juvenile Lectures, "Round of the Water: (iii.) The Atmosphere," Prof. A. O. Rankine. 3 p.m.

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TUESDAY, JANUARY 3RD.

INST. OF AUTOMOBILE ENGINEERS.—At Royal Soc. of Arts, Adelphi, W.C.2. "Electrical Equipment for Automobiles," Mr. E. A. Watson. 7.45 p.m.

WEDNESDAY, JANUARY 4TH.

INST. OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. "Electrical Equipment for Automobiles," Mr. E. A. Watson. 7.30 p.m.

FRIDAY, JANUARY 6TH.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Stress Recorders and their Use in Railway Bridge Work," Mr. G. F. Kent. 7.30 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "Liverpool Overhead Railway," Mr. J. Macnab. 7.30 p.m.

MONDAY, JANUARY 9TH.

CHARTERED SURVEYORS' INSTITUTION.—12, Great George-street, S.W.1. Meeting. 8 p.m.

INST. OF SANITARY ENGINEERS.—Caxton Hall, Westminster, S.W.1. Presidential Address, Mr. Henry C. Adams. 6 p.m.

TUESDAY, JANUARY 10TH.

INST. OF AUTOMOBILE ENGINEERS.—King's Head Hotel, Coventry. "Electrical Equipment for Automobiles." Mr. E. A. Watson. 7.30 p.m.

WEDNESDAY, JANUARY 11TH.

SOCIETY OF GLASS TECHNOLOGY: LONDON SECTION.—Holophane, Ltd., Elverton-street, S.W.1. Discussion, "Automatic Temperature Control of Direct-fired Furnaces," Mr. W. A. Moorehead. 7.30 p.m.

THURSDAY, JANUARY 12TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. "The Zinc Industry," Mr. Stanley Robson. 7.30 p.m.

FRIDAY, JANUARY 13TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "The Compression-ignition Locomotive and its Applicability to British Railways," Lt.-Col. L. F. R. Fell, D.S.O. 6 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION (Joint meeting with Society of Chemical Industry).—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Corrosion of Metals in Salt Solutions and Sea Water," Dr. G. D. Bengough. 7.30 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-Ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Metal Spraying," Mr. Kenneth Gray. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Some Practical Notes on Vibration," Mr. J. Calderwood. 7.30 p.m.

MONDAY, JANUARY 16TH.

INST. OF AUTOMOBILE ENGINEERS.—At Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Electrical Equipment for Automobiles," Mr. E. A. Watson. 7.30 p.m.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Aluminium-bronze," Mr. F. Hudson. 7.30 p.m.

TUESDAY, JANUARY 17TH.

INST. OF AUTOMOBILE ENGINEERS.—Victoria Hotel, Wolverhampton. "Alloy Cast Irons in Automobile Construction," Dr. A. B. Everest. 7.30 p.m.

WEDNESDAY, JANUARY 18TH.

INST. OF AUTOMOBILE ENGINEERS.—Metropole Hotel, Leeds. "Electrical Equipment for Automobiles," Mr. E. A. Watson. 7.15 p.m.

THURSDAY, JANUARY 19TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the University, Edmund-street, Birmingham. "Moulding Sands," Dr. J. G. A. Skerl. 7 p.m.

THURSDAY, JANUARY 26TH.

INST. OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Royal Victoria Station Hotel, Sheffield. Annual dinner. 6.30 for 7 p.m.

THURSDAY, FEBRUARY 2ND.

INST. OF AUTOMOBILE ENGINEERS.—Merchant Venturers' Technical College, Bristol. "Alloy Cast Irons in Automobile Construction," Dr. A. B. Everest. 7 p.m.

CALENDARS, DIARIES, &c.

A.C.E.C., Charleroi, Belgium, and 56, Victoria-street, S.W.1.—Diary.

BIRMINGHAM SMALL ARMS COMPANY, Ltd., Birmingham; AND WILLIAM JESSOP AND SONS, Ltd., Sheffield.—Greeting card.

BRITISH FOUNDRY UNITS, Ltd., Retort Works, Chesterfield.—Greeting card.

BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., Loughborough.—Diary.

BRITISH INSULATED CABLES, Ltd., Prescot, Lancashire.—Desk and wall calendars.

CAMBRIAN WAGON COMPANY, Ltd., Cardiff.—Desk calendar.